TOPICS OF THE MONTH

Strong position for British chemicals

BRITAIN'S chemical industry continues to play its part in the country's export drive and has retained its position of third highest in the list of exporting manufacturing industries, chemical exports having risen from £233 million in 1955 to over £244 million in 1956 and including a slight (0.9%) increase to the dollar area. This year to date exports show a still further increase in value of 11%.

This situation was reported by Mr. G. F. Williams, chairman of the Association of British Chemical Manufacturers, in his speech at the Association's annual general meeting on October 10. Mr. Williams' speech, together with the annual report, reveal the industry as being keenly alive to many other matters apart from production and selling. One is the need for chemical engineering research and, since distillation is a vitally important but extremely complicated operation for chemical manufacture, it is good to note that a start has been made in finding the gaps in knowledge of this subject. Distillation was the first of the subjects which a survey among members of the Association suggested for study, under the chemical engineering research and advisory service set up by the Association with the collaboration of the British Chemical Plant Manufacturers' Association. The A.B.C.M. annual report reveals that the possibility of a corresponding joint filtration panel is being explored.

Both the report and Mr. Williams' speech discuss, as a matter of importance, the Free Trade Area proposed for Western Europe. The A.B.C.M. supported the carrying on of Free Trade Area negotiations, subject to certain safeguards, and set up machinery for an intensive study of the subject. Other matters in which the A.B.C.M. has been active include work study, trade effluent regulations and safety.

New line-up against fuel problems

AN important change of front in British fuel research is indicated by the decision to replace the Fuel Research Station at Greenwich with a new research station at Stevenage, and to carry out there not only the study of the synthesis of carbon monoxide and hydrogen to produce chemicals, and work on atmospheric pollution, but also work in fields other than fuel research, such as mineral processing, for example. The intention to undertake mineral processing research is prompted by, firstly, the increasing demand for metals against a diminishing supply of rich ores, with a consequent need to examine new methods for the treatment of low-grade complex ores; and, secondly, the growing demand for some of the less common metals for such developments as those of atomic energy and the jet engine.

The Research Council's new policy should facilitate more rapid development and exploitation of the results of research in other parts of the Department. The state of fuel research in Britain today has changed a great deal since the Fuel Research Station was first set up, in 1917, and other organisations have since appeared to relieve it of some of its burden—organisations which cover a wealth of investigations relating to coal and coal by-products, gas, electricity, coke, heating and ventilating, gas turbines, etc. The Fuel Research Station's programme has been gone over very carefully to see whether it should be continued at Stevenage or whether it would be better completed at Greenwich or left to some other research organisation. The clear-cut programme now drawn up for Stevenage augurs well for rapid progress in fuel research and should show a marked change from the programme that has hitherto been followed at Greenwich, which will now be replaced since it would be uneconomic to spend more money on the buildings.

The new station at Stevenage will comprise a main service and research laboratory block with a separate wing for administrative offices and library; two buildings to provide accommodation for the intermediate scale work on the synthesis of oil and for similar work on mineral processing and other projects; as well as workshops etc. The estimated cost of the station, including the site, is £750,000, and it is expected to be completed in the spring of 1959. It will accommodate a non-industrial staff of about 220 and an industrial staff of about 120.

Earth and its store . . .

THE most glaring example of unbalance in the world is the difference in material standards of living enjoyed by the industrialised countries and the underdeveloped areas of the world. The backward countries of Asia, Africa and the Middle East look for a solution of their economic and social problems in industrialisation rather than in agricultural innovation. But both will need to develop simultaneously.

This disparity in material standards is disquietingly great; figures could be given to contrast *per capita* tons of steel used, of kilowatts of electricity consumed and so on. If we consider that disparity *per capita* and think of usages when we not only have growth among the present big consumers but also some approach to consumer parity, and both superimposed on a growing world population, we can well stand awestruck at the quantities of raw materials required to ensure some approach to equality of standard. But when the sobering arithmetic of chemical analysis gets to work and we can realise the wide distribution of material percentages in each ton of ordinary igneous rock, percentages of aluminium, of iron, of titanium,

of manganese, chromium, nickel and vanadium, of copper and tungsten, we can be reassured that, given adequate resources of energy, whether provided by nuclear power, or by the sun or the tides, the material prosperity of the world is a long way away from falling down for lack of materials. The solution is in the hands of the technologist.

These comments, made by Sir Alexander Fleck, K.B.E., F.R.S., chairman of Imperial Chemical Industries Ltd., are as thought-provoking as they are arresting, for, as Sir Alexander told the meeting at Workington, Cumberland, where he was lecturing on the impact of technology on our social life, we have a vested interest in a stable world. Present-day industrial operations in the widest sense are so complex and so interdependent that, even allowing for the extraordinary resilience of the human race, a major catastrophe, such as a war fought with nuclear weapons, would probably bring the industrialised countries near to total and permanent ruin. When Imperial Rome finally fell to the barbarians, it took the best part of a thousand years before western Europe again reached a roughly comparable stage of technological achievement. Even if present records were to survive such a holocaust intact, the effort required to re-establish the facilities we should need to win, transport and process raw materials would probably be beyond us. The phoenix, rising afresh from the still warm ashes, has had his day.

Sir Alexander felt that the long-term raw material problem was probably within man's capacity to solve, but the development of the backward countries, so vital if the world is to achieve the necessary measure of stability, will place great demands on capital, both financial and technical. In this era of world-wide industrial development, the scientist pure and applied holds a position of great power and great responsibility.

Diamonds made to order

SYNTHETIC industrial diamonds, for use in the machine-tool industry, are the latest triumph of industrial chemistry and America's General Electric Co. is now on the verge of large-scale commercial production with the prospect of turning out some 3½ million carats a year by the end of 1958. Eventually this will undoubtedly have a considerable effect on the market for natural diamonds, especially in the U.S., which absorbs some 85% of the world's total output of industrial diamonds.

General Electric's scientists and engineers must have worked fast since early in 1955 when it was first announced that synthesis of diamonds had been achieved, for since setting up its pilot plant the company has already produced more than 100,000 carats. Very little has so far been made known about the process, but it can well be imagined that the mechanical and chemical engineering problems posed by the very high pressures and temperatures needed to convert carbon to diamonds were formidable. A recent *Financial Times* report intimates that the research team have developed new means of distributing the stress and giving support to critical parts of the pressure cylinder used. One of these is to use multiple support bands, a technique used years ago in making large gun barrels.

Even more interesting, perhaps, than the General Electric achievement with industrial diamonds is the possibility that similar processes, using very high pressures and temperatures, might be applied to other materials to make still harder products.

Ssh!

'IN the past decade many companies have relaxed their attitude towards security, but there are still too many who impose irksome restrictions on their technical staff. From our own experience we could quote instances of quite unreasonable refusal to permit the publication of articles in the technical press. No one would be foolish enough to expect a company to permit genuine research and process secrets to be divulged to their competitors. The trouble is that some companies assume that every detail of their technical activities is highly secret and forbid their chemists and technologists from writing about anything in the technical press for fear that some arcane particular will slip through and encompass their commercial ruin. Even when every aspect of a piece of work has been well and truly patented by the most skilled exponents of the craft, the blank refusal prevails. Small and struggling companies may be excused for this attitude, but it is difficult to excuse this behaviour on the part of large, and sometimes extremely large, companies. There are surely vast areas of fundamental and applied chemistry about which free and frank discussion can prevail for the benefit of all. A company must be very unsure of itself if it cannot distinguish the really important from the comparatively trivial or well known.'

Every technical journal which strives to serve its readers well will, like us, endorse these comments, which originally appeared in the October issue of *Manufacturing Chemist*. Another journal, *Paint Manufacture*, has also given examples of the ridiculous lengths to which some paint manufacturers go to cloak their formulations in secrecy, even when more than half the formulations in use for production in a progressive firm at any given time will be revised within the year, while very, very few will last five years.

We, too, have had experience of a similarly foolish and short-sighted trend among some companies in the chemical and its associated industries. There are factories where quite simple and harmless details of the plant are sternly withheld at executive level, for no other reason than blind worship of outmoded custom, while the same information will be freely volunteered by workers on the factory floor. There are companies who make it a policy never to publish any articles in the technical press about any aspect of their activities whatsoever. Over such companies and all their doings there broods an all-pervading, impressive silence. But, if you listen carefully, you will hear in the distance the unmistakable cry of the mocking bird.

Automatic control in sugar refining

THE recently installed control system for continuous diffusers at the British Sugar Corporation's factory at Wissington, Norfolk, is believed to be the world's first closed-loop electronic process control installation applied to the process of extracting sugar from sugar beet.

The installation makes use of a variety of transducers for flow, level, temperature, etc., which provide an electric signal which is either applied to three-term process controllers, or used as an input to simple analogue computers. Several of these computers, which are completely integrated into the installation, are employed to provide an output signal which represents the continuous evaluation of the equation governing the part of the refining process to which they are applied. These computers, in conjunction with the three-term mode of process control, are stated to permit extremely fine control of the manufacturing process.

The installation was designed by Evershed & Vignoles Ltd., in conjunction with the British Sugar Corporation, and the graphic control panel embodies a number of miniature recorders which will provide a permanent record of the performance of the plant, and will also furnish data for accountancy purposes etc. The control panel also includes provision for bumpless transfer from automatic to manual operation of the plant and an automatic alarm system.

Gas chromatography in process control

TECHNIQUES of gas phase chromatography have had an almost revolutionary impact on laboratory analysis. Development of automatic process analysers based on these techniques has proceeded extremely quickly and a number of analysers are now commercially available.

Such analysers are now being applied to automatic process analyses at a rapidly increasing rate, but few results have yet been made public. Information thus far obtained has substantiated a number of advantages for automatic chromatographic analysers and permits highly favourable comparison with other types of automatic analysers, according to Mr. B. O. Ayers, of Phillips Petroleum Co., Bartlesville, Oklahoma, who presented a paper on this subject to the International Symposium on Gas Chromatography held in Michigan recently. Perhaps the most striking advantage of these analysers is the wealth of data available at a relatively low instrument cost. As an example, use of a chromatographic analyser on the terminal unit of a process not only permits monitoring and control of the terminal unit but may indicate operating upsets in preceding units through the detection of components normally absent at the sample point.

Increasing plant use of these analysers will uncover a number of problems. As these problems are solved and adaptability to control use is more fully developed, chromatographic analysers may prove to be one of the most widely used instruments in process monitoring and control.

Graphite in cathodic protection

THE effectiveness of the impressed-current system of cathodic protection for staving off the electrolytic corrosion of a mild-steel plate immersed in tap water was recently demonstrated using an impervious graphite anode and therefore illustrating one of the more recent applications of graphite in the process and chemical industries.

There are a number of cases in the process industries where the installation of a cathodic protection system using graphite anodes has proved to be a sound economic proposition. The Morgan Crucible Co. Ltd. give such examples as the protection of water boxes on power station condensers, which are often subject to corrosion by brackish water or brine, and also of brewery pasteurisers, a range of which is now marketed having an incorporated cathodic protection system. Cooling tanks in air-conditioning systems have proved another suitable application, as have also various immersed-coil heat-exchanger systems involving dissimilar metals.

An article on cathodic protection, by C. L. Wilson, B.SC., was published in the October issue of C.P.E.

Babcock and Royal Ordnance Factory take-over

THE world demand for power is increasing, whether it be generated from conventional or atomic fuels, and this is well illustrated in the plans of Babcock & Wilcox Ltd. to take over the Royal Ordnance factory at Dalmuir. Besides providing steam-raising plants, pressure vessels, etc., to the oil and chemical industries, the company has designed and built the giant steam-raising units for both the Calder Hall and Chapelcross nuclear power stations, and is closely concerned with the design and construction of much larger atomic power stations both for the United Kingdom and abroad.

While, in their present Renfrew factory, Babcock have the world's largest single manufacturing plant devoted to the production of land and marine power plant and ancillary equipment, they need additional facilities, and there is much to attract them at Dalmuir —especially the excellent fabrication and assembly areas for the construction of pressure vessels, and for the general engineering work required by the power industry.

Getting away from nitroglycerine

MANUFACTURE of nitroglycerine in a completely remote-controlled plant for the first time was signalled at the Ardeer factory of I.C.I.'s Nobel Division recently. Here the Biazzi unit, which first started producing nitroglycerine early last year and was described in CHEMICAL & PROCESS ENGINEERING in August 1956, went through a test run under remote control and the performance was stated to be very satisfactory.

Previously, the control desk has been situated inside the nitrating house, but after some 16 or 17 months of successful operation the plant was closed

for the necessary structural modifications and for the erection of the instrument panel and control desk in a reinforced concrete room removed from the nitrating building. A partition was erected lengthwise in the nitrating room from which the control desk had been removed. Behind that partition two television cameras now observe the process vessels through a long window.

What the cameras see is relayed by closed circuit to the remote control room, and reproduced on two small TV screens installed on the main instrument panel. In addition to this visual observation the 'hillmen' can also hear the sounds of operation because microphones and an intercommunication system link the nitrating room and the remote control centre. In special circumstances during testing and in the preparation for the start-up of nitration a hillman in the process building can converse with his companions in the remote control room and instructions can pass between them.

The successful operation of the remote-controlled unit represents a considerable advance in the safe manufacture of this tricky explosive.

Greece plans lignite industries

IN an impressive ceremony the inauguration took place recently of a $21-million project which will at last utilise the extensive lignite deposits of Ptolemais in north-western Greece. The entire project has been undertaken by the Greek Mining & Industrial Co. for Ptolemais Lignite Inc., with the German firm of Krupp acting as technical adviser for the research, construction and initial operation of the plant.

Scheduled for completion by March 1959, the works consist, on the one hand, of the lignite-extracting installations and, on the other, of a group of industries that will produce lignite briquettes and semi-coke, while a thermo-electric power plant using lignite will generate steam and electricity. To start with, a minimum of 1.8 million to 2 million tons p.a. will be mined, although, according to calculations which have been made, an annual production of 5 million tons would eventually seem to be best from the economical point of view.

Repeated analyses of Ptolemais ore have been made in both German and Greek laboratories and the lignite has been found to fall into two categories; it is estimated that during the first stages of production some 700,000 tons of the annual yield of one grade will go into lignite bricks and semi-coke, while 1.3 million tons of the other grade will be used for the generation of electric power.

Provided that an annual production of 5 million tons of lignite is to be accomplished, and the processing of bricks of lignite A into semi-coke effected, additional processing for carbonification by-products, such as tar, light and medium oil and phenolide liquids, seems also possible. No final analysis has yet been made, but indications prove that such an extension would be economically sound, particularly if the nitrate fertiliser plant is established in the same area. There is also thought of establishing a synthetic gasoline plant with raw material provided from the by-products of carbonification, and of further processing the phenolide liquids into phenol, which can be used as the raw material for the production of plastics.

New process separates rare earths

LIQUID ion exchange is being tried out as a new way of achieving high-efficiency separation of rare earths which might have potentialities as a large-scale, continuous process. Petroleum ether is used as a carrier with 2-diethylhexylphosphoric acid (DHPA) contacting a water solution of mixed rare-earth chlorides. The rare earths move very quickly into the petroleum ether, from which they are extracted with ammonium citrate. By regulating the *p*H of the extractant and its weight ratio to the petroleum ether layer, preferential extraction of individual rare earths is obtainable. These are then precipitated as oxalates and fired to oxides.

Details of the process were given in the September issue of *Chemical & Engineering News* and it is believed that, while it is too early to discuss the engineering aspects of using it on a very large scale, if the process comes up to expectations commercial production would not require a very large system. One disadvantage is the use of petroleum ether, requiring a closed system. However, more facts about the process should emerge from bench-scale trials being carried out at Horizons Inc., Cleveland, U.S., where the process is being developed by Mr. R. C. Vickery, head of the company's chemistry department.

Hydrogenation catalysts

THE value of platinum metals as acid-supported catalysts to up-grade low-octane petroleum spirits is well known and now more experiments have been conducted to determine their applications as catalysts for hydrogenation reactions.

While platinum metals are highly active for the hydrogenation of olefinic double bonds, problems of a somewhat different nature are encountered in the hydrogenation of acetylenic bonds, which is a two-stage process. Considerable interest here attaches to the selective production of the intermediate olefine, while the catalytic hydrogenation of, in particular, acetylene is accompanied by a hydropolymerisation reaction leading to butanes, hexanes and higher hydrocarbons. In addition, the reduction of the acetylenic bond is often stereospecific, leading chiefly to the formation of the corresponding *cis*-olefine.

This subject is treated by Dr. G. C. Bond in *Platinum Metals Review* and he mentions the wide variety of physical forms in which platinum metals are catalytically employed. Most metals of the platinum group have been successfully supported on synthetic polymers, and such catalysts are very effective for certain purposes, but in reforming processes Al_2O_3/SiO_2 is commonly used.

A Graphical Method for the Calculation of

SIMULTANEOUS HEAT AND MASS TRANSFER

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A graphical method is given for the calculation of the interface conditions in case of simultaneous heat and mass transfer. The method can be used for the design of tubular cooler condensers and for the design of direct gas-liquid contact equipment, e.g. water heaters, gas saturators, gas coolers, driers etc.

Gas-liquid interface conditions are found graphically in a diagram of the logarithm of the partial pressure of the non-diffusing gas component against the temperature. The use of a diagram of this type eliminates trial and error calculations.

The steps involved are summarised for the special case of the design of a cooler condenser.

SIMULTANEOUS heat and mass transfer is encountered in cooler condensers, direct-contact equipment such as gas coolers, water heaters, gas saturators, driers, evaporation coolers etc. In all these and similar operations, mass transfer occurs by diffusion of one or more components through a stagnant gaseous phase.

Colburn and Hougen[1] have written the basic equation of this type of process for the special case of a cooler condenser as follows:

$$dQ = h_o(t_i - t_w)\,dA = h_g(t_g - t_i)\,dA + k_g\lambda_i(p_v - p_i)\,dA = U(t_g - t_w)\,dA \quad \ldots\ldots\ldots\ldots (1)$$

The combined heat transfer coefficient h_o represents all resistances to heat transfer, except those in the gas phase. Thus the coefficient h_o includes the condensed liquid, the tube wall, dirt and scale layers, and the cooling water film. The combined coefficient h_o can be calculated by conventional methods. In most cases, h_o will be constant between inlet and outlet.

The gas side heat and mass transfer coefficients, h_g and k_g, may be calculated by any of the correlations available in the literature, *e.g.* those presented by Chilton and Colburn:[2]

$$h_g = \frac{j_h c G}{Pr^{2/3}} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

$$k_g = \frac{j_m G M_v}{M_m p_{gf} Sc^{2/3}} \quad \ldots\ldots\ldots\ldots\ldots (3)$$

The relation between the gas temperature t_g and the cooling water temperature t_w can easily be established in the case of saturated gas-vapour mixtures, when the assumption is made that the mixture remains saturated during its flow through the equipment.

When this assumption would not be accurate enough, or when the gas-vapour mixture is non-saturated, the calculation of the relation between t_g and t_w is more complicated. Then, the condition of the gas-vapour mixture, in respect to its temperature t_g and partial vapour pressure p_v, may be followed by using an equation proposed by Colburn:[3]

$$\frac{dp_v}{dt_g} = \frac{\triangle p}{\triangle t} \cdot \frac{(P - p_v)}{p_{gf}} \cdot \left(\frac{Pr}{Sc}\right)^{2/3} \cdot \left(\frac{e^{\varepsilon} - 1}{\varepsilon e^{\varepsilon}}\right) \quad \ldots. (4)$$

This equation can be derived from the relations given by Colburn and Drew[4] for the condensation of binary vapour mixtures. The condensation of vapours from non-condensing gases represents a limiting case of the condensation of binary vapour mixtures. Another derivation of an equation of this type was given by the author.[5] He has also used this equation as the basis for a graphical design procedure for cooler condensers[5] and for gas coolers.[6] The design calculations were carried out in a diagram of partial vapour pressure against temperature.

Equation (1) contains two unknowns, namely t_i and p_i. Equation (3) contains the unknown p_i, because $p_{gf} = (p_v - p_i)/ln\,[(P - p_i)/(P - p_v)]$. Evidently, a direct solution of Equation (1) is not possible. Colburn and Hougen[1] have, therefore, solved this equation by trial and error. It is generally agreed that these trial-and-error computations make the method very troublesome and time consuming.

Colburn and Hougen[1] have pointed out that the composition and, therefore, the properties and gas mass velocity of the gas mixture may change considerably from inlet to outlet. This is mainly due to the change in the partial pressure of the vapour component, and to a minor extent to the change in the temperature. Then it will be necessary to solve equation (1) at various points. The area A can

be calculated by graphical integration of equation (1), or

$$A = \int dA = \int \frac{dQ}{U(t_g - t_w)} \quad \ldots\ldots\ldots\ldots (5)$$

Recently the author[7] has presented a graphical method for the determination of the interface conditions in cooler condensers. In this method a diagram was used in which the logarithm of the partial pressure of the non-condensing gas is plotted against the temperature. The use of this type of diagram enables the straightforward and rigid determination of the interface conditions t_i and p_i, whereby all trial-and-error computations are eliminated.

The purpose of the present article is twofold:

(1) To enlarge the method from tubular cooler condensers to direct-contact equipment.

(2) To present an improved graphical procedure for the determination of the interface conditions t_i and p_i.

Direct-contact equipment

The procedures indicated above for the design of cooler condensers may also be used for the design of direct-contact equipment, when the following provisions are made.

(*a*) The combined heat transfer coefficient h_o is replaced by the liquid film coefficient h_l or its equivalent if the film theory is not used.

(*b*) The cooling water temperature t_w is replaced by the temperature of the main body of the liquid, t_l.

(*c*) The proper equations for the gas side heat and mass transfer coefficients are used, in case the Chilton-Colburn correlation would not apply, as may be the case in packed towers.

Design equations

To keep the derivation of the following equations general, the combined heat transfer coefficient h_o will be used. This coefficient reduces to the liquid side coefficient h_l, in case of direct contact between gas and liquid. The temperature t_l will represent the temperature of the main body of the liquid in both cases.

The mass transfer coefficient k'_g can be written:

$$k'_g = \frac{j_m G M_v}{M_m\ Sc^{2/3}} = k_g\ .\ p_{gf} \quad \ldots\ldots\ldots\ldots (6)$$

Thus

$$k_g = \frac{k'_g}{(p_v - p_i)}\ .\ ln\frac{(P - p_i)}{(P - p_v)} \quad \ldots\ldots\ldots\ldots (7)$$

When equation (7) is substituted in Equation (1), the following relation is obtained after rearranging:

$$dQ = h_o(t_i - t_l)dA = h_g(t_g - t_i)dA + k'_g\lambda_i\left\{ln(P - p_i) - ln(P - p_v)\right\}dA \quad \ldots\ldots\ldots\ (8)$$

or

$$\frac{h_o}{h_g}\ .\ (t_i - t_l) - (t_g - t_i) = \frac{k'_g\lambda_i}{h_g}(ln\,p_{gi} - ln\,p_{gv}) \ldots. \quad (9)$$

From Equations (2) and (6) follows:

$$\frac{k'_g\lambda_i}{h_g} = \frac{L_i}{C_m}\ .\ \left(\frac{Pr}{Sc}\right)^{2/3}\ .\ \frac{j_m}{j_h} = F \quad \ldots\ldots\ldots (10)$$

Substitution of $F = k'_g\lambda_i/h_g$ and $R = h_o/h_g$ in Equation (9) delivers:

$$R(t_i - t_l) - t_g + t_i = F(ln\,p_{gi} - ln\,p_{gv}) \quad \ldots\ldots\ldots (11)$$

The temperature t_B is defined:

$$t_B = \frac{Rt_l + t_g}{R + 1} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots (12)$$

NOTATION

A	=	Area, sq. ft.
c, c_{pv}	=	Specific heat at constant pressure of gas-vapour mixture and vapour, respectively, B.Th.U./lb.°F.
c_w, c_l	=	Specific heat of liquid, B.Th.U./lb.°F.
C_m	=	Specific heat at constant pressure of gas-vapour mixture, B.Th.U./lb.mol.°F.
D	=	Diffusion coefficient, sq.ft./hr.
F	=	$k'_g\lambda_i/h_g$, °F.
F'	=	$(L_v/C_m)\ .\ (Pr/Sc)^{2/3}$, °F.
F_c	=	See Equation (18), °F.
G	=	Mass velocity of gas-vapour mixture, lb./hr./sq.ft.
G_o	=	Flow rate of vapour-free gas, lb./hr.
h_o	=	Combined heat transfer coefficient for cooling water, tube wall, scale and condensate, B.Th.U./hr./sq.ft./°F. In case of direct contact between gas and liquid, h_o reduces to h_l, the liquid film heat transfer coefficient, B.Th.U./hr./sq.ft./°F.
h_g	=	Gas side heat transfer coefficient, B.Th.U./hr./sq.ft./°F.
j_h, j_m	=	Heat and mass transfer factor, respectively, dimensionless.
k	=	Thermal conductivity of gas-vapour mixture, B.Th.U./hr./ft./°F.
k_g	=	Gas side mass transfer coefficient, lb./hr./sq.ft. atm.
k'_g	=	$k_g\ .\ p_{gf}$, lb./hr./sq.ft.
L	=	Liquid flow rate, lb./hr.
L_v, L_i	=	Latent heat of evaporation, respectively, at main body of gas-vapour mixture and at gas-liquid interface, B.Th.U./lb.mol.
M_v, M_m	=	Molecular weight of vapour and of gas-vapour mixture, respectively, lb./lb.mol.
P	=	Total pressure, atm.
Pr	=	Prandtl number, $c\mu/k$, dimensionless.
p_v, p_i	=	Partial vapour pressure in the gas-vapour mixture, and at the gas-liquid interface, respectively, atm.
$\triangle p$	=	$p_v - p_i$, atm.
$\triangle ln\ p_g$	=	$ln\ p_{gi} - ln\ p_{gv}$
p_{gi}, p_{gv}	=	Partial pressure of the non-diffusing gas component, respectively, at gas-liquid interface and at main body of the gas-vapour mixture, atm.
p_{gs}	=	Partial pressure of the saturated non-diffusing gas component, atm.
p_{gf}	=	Logarithmic mean partial pressure of non-diffusing gas, atm.
Q	=	Total heat transferred, B.Th.U./hr.
R	=	h_o/h_g, dimensionless
R_c	=	See Equation (17), dimensionless
Sc	=	Schmidt number, $\mu/\rho D$, dimensionless
t	=	Temperature, °F.
t_B	=	Reference temperature, see Equation (12), °F.
t_g, t_i, t_w	=	Temperature of gas mixture, of gas-liquid interface and of cooling water, respectively, °F.
t_l	=	Temperature of main bulk of liquid, °F.
$\triangle t$	=	$t_g - t_i$, °F.
U	=	Overall heat transfer coefficient, B.Th.U./hr./sq.ft./°F.
ε	=	$-k_g\triangle pc_{pv}/h_g$, dimensionless
λ	=	Latent heat of evaporation, B.Th.U./lb.
ρ	=	Density of gas-vapour mixture, lb./cu.ft.
μ	=	Viscosity of gas-vapour mixture, lb./hr.ft.

When Equation (12) is substituted in Equation (11), the following relation is obtained after rearranging:

$$(R + 1)\ (t_i - t_B) = F(ln\,p_{gi} - ln\,p_{gv}) \quad \ldots\ldots\ldots (13)$$

Thus

$$\frac{(ln\,p_{gi} - ln\,p_{gv})}{(t_i - t_B)} = \frac{R + 1}{F} \quad \ldots\ldots\ldots\ldots\ldots (14)$$

or

$$\frac{(\log\,p_{gi} - \log\,p_{gv})}{(t_i - t_B)} = \frac{R + 1}{2.303F} \quad \ldots\ldots\ldots (14a)$$

Graphical procedure

Equation (14a) can easily be solved for the interface temperature t_i in a diagram of log p_g against the temperature (see Fig. 1). In this semi-logarithmic plot, the curved line represents the saturation line, plotted as the partial pressure of the saturated non-diffusing gas against the temperature. Point A represents the known condition of the gas-vapour mixture $t = t_g$ and $p_g = p_{gv}$. Point B represents the reference point, and it has the co-ordinates $t = t_B$ and $p_g = p_{gv}$. Through point B, a straight line with a slope equal to $(R + 1)/2.303F$ is drawn. This straight line intersects the saturation line in point C. In accordance with Equation (14a), point C will have the co-ordinates $t = t_i$ and $p_g = p_{gi}$.

It may be seen that this new design method is rigid and straightforward and requires no trial-and-error computations. It is an improved version of the method recently given for the design of cooler condensers.[7] In this latter method, a reference temperature and two points had to be calculated. In the method given here, only a reference temperature and the slope of a tie line are required.

Corrected heat transfer

For most engineering calculations it may not be necessary to correct the equations derived above for the sensible heat transferred by the diffusing vapours. It may nevertheless be useful to show the application of the graphical design method for this case.

The corrected rate of sensible heat transfer at the gas-liquid interface was recently derived by the author:[6]

$$dQ_s = h_g \triangle t \cdot \left(\frac{\varepsilon}{e^{\varepsilon} - 1}\right) dA \quad \ldots\ldots\ldots\ldots\ (15)$$

where

$$\varepsilon = \frac{-k_g \cdot \triangle p \cdot c_{pv}}{h_g} = \frac{-k'_g \cdot \triangle \ln p_g \cdot c_{pv}}{h_g} \quad \ldots\ (16)$$

When the corrected rate of sensible heat transfer, Equation (15), is used in Equation (8) instead of $h_g \triangle t dA$, the following corrected values for R_c and F_c are derived, respectively:

$$R_c = \frac{h_o}{h_g} \cdot \frac{(e^{\varepsilon} - 1)}{\varepsilon} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ (17)$$

$$F_c = \frac{k'_g \lambda_i}{h_g} \cdot \frac{(e^{\varepsilon} - 1)}{\varepsilon} = \frac{L_i}{C_m} \cdot \left(\frac{Pr}{Sc}\right)^{2/3} \cdot \frac{j_m}{j_h} \cdot \frac{(e^{\varepsilon} - 1)}{\varepsilon} \quad (18)$$

Then the reference temperature should be written:

$$t_B = \frac{R_c t_l + t_g}{R_c + 1} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ (19)$$

Equation (14a) will then read:

$$\frac{\log p_{gi} - \log p_{gv}}{t_i - t_B} = \frac{R_c + 1}{2.303\, F_c} = \frac{R + \left(\frac{\varepsilon}{e^{\varepsilon} - 1}\right)}{2.303\, F} \quad (20)$$

It is most convenient to solve this equation in a diagram in which the logarithm of the non-diffusing gas is plotted against the temperature. However, a direct solution cannot be obtained because the value of ε cannot be calculated before the interface conditions are known. Therefore, it is recommended to assume an estimated value for $\varepsilon/(e^{\varepsilon} - 1)$ in the calculation of t_B by Equation (19), and the slope of the tie lines by Equation (20). Often it may be proper to assume $\varepsilon/(e^{\varepsilon} - 1) = 1.0$ as a first approximation. Then the application of the graphical procedure will deliver approximate interface conditions.

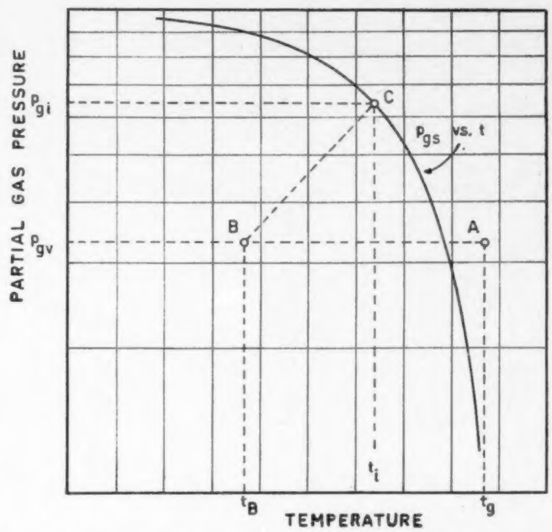


Fig 1, referred to in the discussion of graphical and design procedure in the text.

From the value for p_i or log p_i found in this way, an improved value for ε can be calculated by Equation (16). Also improved values for t_B and the slope are calculated by Equations (19) and (20), respectively. Then the graphical determination of the interface conditions is repeated. Usually, after one or two of these trials, the interface conditions can be determined with sufficient accuracy.

Design procedure

It has been pointed out that the graphical method for the determination of the interface conditions can be used for all types of simultaneous heat and mass transfer in which vapour diffuses through a more or less stagnant gaseous component.

For convenience, the course of the calculations will be given for the special case of a cooler condenser handling a saturated gas vapour mixture.

(a) Fix inlet and outlet temperature of the cooling water and the gas-vapour mixture. Calculate the value of L/G_o from an overall heat balance.

(b) Various intermediate values for the gas temperature and the cooling water temperature are calculated assuming the gas-vapour mixture remains saturated. This step involves the calculation of the enthalpy of the gas-vapour mixture at various gas temperatures, t_g. The cooling water temperature t_w is obtained from a relation of the type $Lc_w dt_w = G_o di$, after integration.

(c) Calculate the combined heat transfer coefficient h_o. If this coefficient shows appreciable variations from inlet to outlet, it should also be calculated for various points. Usually, h_o can be taken as constant, however.

(d) Calculate the gas side heat and mass transfer coefficient h_g and k'_g and calculate $F = k'_g \lambda_i / h_g$ for various points. In many cases it will be accurate enough to replace F by $F' = (L_v/C_m) \cdot (Pr/Sc)^{2/3}$ in which all physical properties are taken as for the bulk of the gas-vapour mixture. For saturated gas vapour mixtures, F' can be calculated in advance. It will be convenient to prepare a plot of F' *versus* t, especially when series of calculations for the same gas-vapour mixture are to be made. If a plot of F' *versus* t is available, the point-to-point calculation of

(*Concluded on page* 431)

CATALYST FACTORY

I.C.I. Modernise Lancashire Plant

The Clitheroe catalyst factory of I.C.I. has been extended and modernised so that not only has manufacturing capacity been doubled but the costly process of manufacturing catalysts has been made highly efficient and economical. The latest ideas in instrumentation and automatic control have been brought to bear on the processes of preparing and precipitating the various solutions, drying and pelleting, while a well-devised dust-collection system also plays an important part in the factory's operation.

BELIEVED to be the only self-contained factory designed and operated solely for catalyst production, the Clitheroe factory of Imperial Chemical Industries Ltd. (Billingham Division) produces 2,500 tons p.a. of catalysts of various types, in the form of pellets or granules, for carbon monoxide removal (shift reaction), methanation (removal of CO traces), sulphur removal, hydrogenation, dehydrogenation, hydrocarbon oxidation, etc. The present extensions will cater not only for future I.C.I. requirements but will also enable the company to offer catalysts for sale on a world-wide basis.

Background story

The factory at Clitheroe, which is near Blackburn, Lancs., owes its origin to the war-time need for a catalyst factory that would be comparatively safe from air attack. It was designed and erected by I.C.I. at the Government's request, and the company supervised its operation until finally, in 1950, it bought the factory from the Government. In 1954 it became apparent that I.C.I.'s catalyst needs would soon overtake the original capacity, and it was decided to rebuild the works, modernising all sections and expanding its capacity considerably.

Scheme of factory

The present factory, operating round the clock seven days a week, covers a site area of some 7 acres and has a labour force of just over 200 men, of whom about 70 are employed in process operations. There are three process buildings, together with stores, services and amenity buildings. The process sections are

(*a*) Pasting section for wet processing.

(*b*) Oven section for drying, decomposition, calcination etc.

(*c*) Pelleting section for dry processing.

Most of the equipment items are general purpose units enabling several catalysts to be made at any one time. Some 20 different 'standard' catalysts are made in production campaigns lasting from a few weeks to several months, and forward production planning is essential in order to achieve maximum production efficiency.

Pasting section

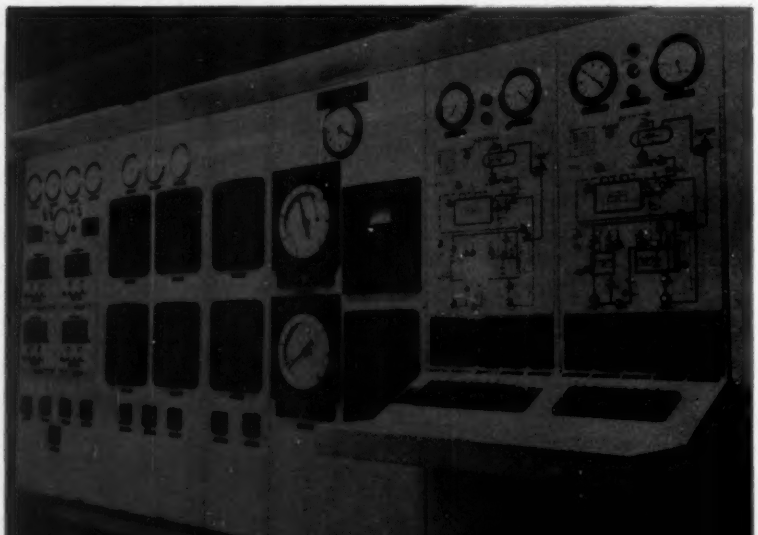
The new pasting section is a four-storey building, the ground floor of which contains reaction vessels and most of the interconnecting pipe work. The first floor is the main operating floor, whilst the top two floors are mainly for handling and intermediate storage of raw materials from the main store.

Stock solutions are prepared from metals or salts and these can be maintained at controlled temperatures if necessary. Preset volumes of these solutions are passed to precipitation vessels at controlled rates and temperatures and after a set period of time suspended precipitates are pumped to pressure filters, where they are subsequently washed.

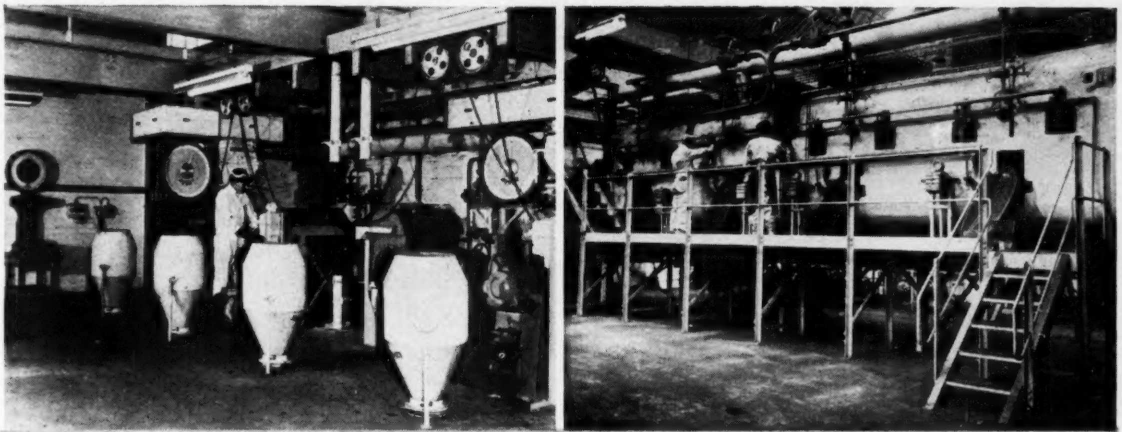
All operations in this section can be preset and then controlled either automatically or by hand from one of the two control panels.

Oven section

A number of tray drying ovens have been retained in this section, whilst three new continuous-band drying ovens and one special-purpose continuous calcining oven have been installed. Washed filter cakes can be dropped either to trays or to one of the bands for drying or drying/decomposition as necessary, the dried or decomposed product being moved to the pelleting section in standard skips. Most of the ovens are gas-fired and are



Control panel for precipitation and filtration plant at Clitheroe.



Two views of the Clitheroe catalyst factory showing (*left*) the preparation of intermediate materials prior to pelleting, and (*right*) drying ovens through which the catalyst materials pass.

fitted with enclosed discharge systems to eliminate dust hazards, since some dusts are toxic. Steam and electric drying ovens are also available and all units in the oven bay have been fitted with modern safety devices.

Pelleting section

This section is housed in a four-storey building in which gravity flow of materials is used wherever possible. Intermediate products from the oven section or sometimes raw materials from store are elevated to the highest point required for the particular catalyst and are intermittently dispensed from storage hoppers, in controlled amounts, to crushing, mixing, granulating, pelleting or briquetting machines as required. Travelling weigh hoppers are extensively used and enable maximum flexibility to be achieved between hoppers and various items of mechanical equipment. A wide variety of equipment is available in this section, from which catalysts can be produced in many shapes and sizes although the majority of products are either solid cylindrical pellets or near spherical granules

Manual operations and man-handling of materials have been reduced to a minimum in all sections.

Cylindrical pellets are made on high-speed rotary machines, most of which are capable of producing up to 80,000 small pellets per hour; a quarter of a million pellets/hr. can be achieved with some of the machines. High-speed pelleting is essential since in commercial use a charge of catalyst can contain over 100 million pellets, but pellet strength is equally important to give a long catalyst life and high pelleting pressures are employed.

Control of iron problem

Iron oxide is a major constituent of some catalysts but is also extremely detrimental to many other metal oxide catalysts, and the pelleting section is, therefore, laid out to process 'iron-bearing' and 'iron-free' catalysts in separate compartments in order to avoid cross contamination arising from catalyst dusts. Dust control in general has been well planned and all operations from which there is likely to be any dust emission are connected either to a general extraction system, or to individual dust collecting units if the dusts are capable of re-use or are worth separate recovery. Catalysts are expensive products with values in some cases over £1/lb. and mechanical losses must be reduced to a minimum at all stages of manufacture.

In a third separate compartment of the pelleting section there is a self-contained plant devoted entirely to the manufacture of olefine polymerisation catalysts, a product made under licence from Universal Oil Products, U.S., and sold by I.C.I. to U.O.P. licensees operating outside the U.S.

Calculation of Simultaneous Heat and Mass Transfer

(*Concluded from page* 429)

the mass transfer coefficient k'_g can be omitted, as has been pointed out recently by the author.[8] When the value of F' varies little over rather wide temperature ranges, it is often possible to assume an average constant value for F'.

(*e*) Calculate the value of $R = h_o/h_g$ for various points.

(*f*) Calculate the reference temperature t_B for various points by Equation (12).

(*g*) Calculate the value of the slope $(R + 1)/2.303F$ for various points.

(*h*) Determine graphically the interface temperatures t_i in a diagram of log p_g against t, as shown in Fig. 1.

(*i*) Calculate the heat flux $h_o(t_i - t_w)$ at various points.

(*j*) Calculate the total heat transferred, Q, at various points. The value can easily be derived from the gas enthalpy or cooling water temperature.

(*k*) For the graphical integration of Equation (5), plot the reciprocal heat flux $1/h_o(t_i - t_w)$ against the total heat transferred, Q, and measure or calculate the area under the integration curve so obtained, from the zero ordinate. The area found in this way is equal to the area A.

REFERENCES

[1]A. P. Colburn and O. A. Hougen, *Ind. Eng. Chem.*, 1934, **26**, 1178.
[2]T. H. Chilton and A. P. Colburn, *Ibid.*, 1934, **26**, 1183.
[3]A. P. Colburn, *Proc. Inst. Mech. Engrs.*, 1951, **164**, 448.
[4]A. P. Colburn and T. B. Drew, *Trans. Am. Inst. Chem. Engrs.*, 1937, **33**, 197.
[5]G. H. P. Bras, *Chem. Eng.*, 1953, **60** (4), 223; (5), 238.
[6]*Idem, Ibid.*, 1954, **61** (12), 191; 1955, **62** (1), 195.
[7]*Idem, Chem. Eng. Sci.*, 1957, **6**, 277.
[8]*Idem, Petr. Refiner*, 1956, **35** (6), 177.

CENTRIFUGING

By E. Broadwell

Part I . . . *Practical and theoretical studies of centrifuging; new laboratory and industrial machines; countercurrent extraction; separation of petroleum products etc.*

IN assessing the published information under review it is apparent that steady progress in this field is being maintained, particularly in view of the number of new machines which are available, but much essential basic information is still lacking and even that which is available is very scattered. It is hoped that some day a really comprehensive and balanced resumé of the whole field will be written to remedy this omission.

Increasing interest in this field is shown by way of a symposium held under the auspices of the American Institute of Chemical Engineers. This is the first time a symposium has been held on this subject and it is to be hoped it will be a forerunner of others both in America and elsewhere. The papers presented have not been published in the technical press yet, but a useful summary has been given by Maloney[1] in one of his annual reviews on this subject. In all, nine papers were presented ranging from fundamental studies, selection, scale up, evaluation, to applications. The remainder of this review together with a further one by the same author[2] cover in a concise manner some of the new machines, developments, applications and patents of particular interest to American readers.

General reviews

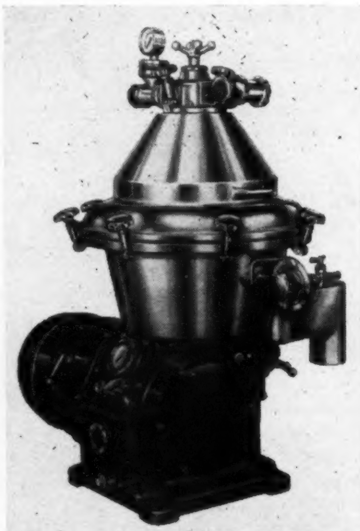
A comprehensive survey of the major methods of solids/liquid separations[3] is a useful starting point for the consideration of any new separating problem of this type. In the first article by Smith[4] the approach to the problem is on basic lines and indicates the type of information required in the form of a questionnaire, prior to selection of equipment. When considering centrifugals, some simple small-scale tests are suggested which serve to indicate the types to be investigated further. This matter is then expanded by Flood,[5] who first suggests some points for close consideration prior to evaluation of machine selection. He then goes on to describe the range of machines manufactured by some American companies; for convenience these are briefly classified in a table. Considerable detail is given concerning the characteristics, operation, advantages and limitations of the various machines. There are a number of other types of machines and well-established operating principles which might have been included, but this section of the survey is nevertheless quite useful. Whilst referring to specific machines available in America, the majority or similar types are available in Great Britain, and the basic information is therefore still applicable.

A number of other references giving the characteristics and fields of application of centrifuges have appeared. Three sections of a recent book[6] are devoted to this topic; the overall information is not as comprehensive and well balanced as one would have wished and there is some duplication of information; the result of two different authors writing on the same subject. The first of the sections[7] is devoted mainly to the description of the Sharples tubular bowl machines and a very brief description of their use in continuous vegetable oil refining and soap production. The second, written by Gillies,[8] covers a much wider field and is in a more usable form. A table is drawn up giving the types of high-speed bowls which are available and classifying the type of problem to which they can be applied. These are then considered in greater detail in relation to typical applications; in considering capacities of machines the need to consider the material to be processed is illustrated by a table showing the optimum throughput for an assortment of materials for a given type of machine. The concluding section on this topic[9] covers continuous centrifuges for the sugar industry, and is mainly concerned with the Escher Wyss single- and multi-stage push types.

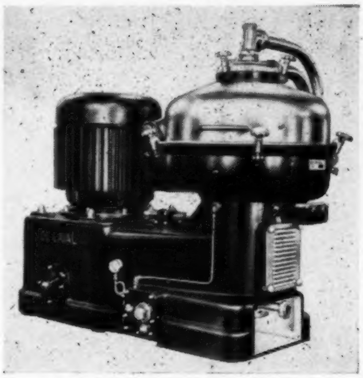
A further review,[10] describes some high-speed machines which are available and the type of problem for which each is designed. This article also contains a table classifying the various types, but there are a number of omissions which detract from its value as a 'guide to the selection of continuous centrifuges.'

One further review of a balanced nature has been prepared by Trawinski.[11] Three tables are presented covering industrial machines with respect to their running characteristics, dimensions, capacity and horsepower, a very thorough detailed description of each class and a comparison between the centrifuges and equivalent gravity settling equipment.

The basic theory of centrifugal



A new-design, intermittent-solid-discharging centrifuge, type BRPX 30930S, has all product contact parts of stainless steel with easy-clean features. It is arranged with pressure discharge and is suitable for clarifying liquids with solid contents up to 2%. (Alfa-Laval Co. Ltd.)



One of the new range of De Laval continuous solid discharging, nozzle-type centrifuges. This particular machine is type TX 21230, as used in the starch industry for washing the starch during its separation within the centrifuge bowl.

separation is briefly discussed in a further article,[12] with the object of showing the advantages of the Podbielniak countercurrent contactor over tubular and disc-type bowls. Some of the listed disadvantages of the latter must be considered in the light of the purpose of the article, which follows a practice all too common amongst information published by centrifuge manufacturers. This report then goes on to describe the application of Podbielniak machines to soya-bean oil degumming, to be referred to in Part 2 of this review. The use of such machines for continuous caustic soda refining of vegetable oils is also suggested.

Fundamental studies

Turning to fundamental matters, two practical studies and one theoretical have been reported. Storrow *et al.*[13] continue to add to the work previously reported in these reviews; in this latest contribution, previously developed techniques are utilised to confirm the basic flow equations obtained from their first studies by applying the data obtained from a study of liquid flow through ceramic and sintered bronze mediums in a centrifuge basket. The further report[14] concerns a study of the liquid retention of different types of porous solids and includes data on liquid removal under various degrees of centrifugal force. The various liquids used have different physical characteristics and, whilst the results showed some divergence, it was possible to derive equations and present them in chart form. This method can be useful for estimating the liquid retention of centrifuged cakes.

Bergner[15] has recorded a most detailed mathematical study of particle size distribution from a centrifugal separation point of view; the paper is concerned only with liquids having a solid content of about 0.5%. It is concluded that the distribution of the smallest particles determines the degree of separation; the feed rate to a centrifuge is a function of the limiting value of the sedimentation constant of the solids and that the efficiency of a particular centrifuge cannot be calculated. Comparative efficiencies can be arrived at, however, to give reasonably reliable information and this is illustrated in the consideration of parallel and series operation applied to the separation of milk and heavy fuel oil. The theory of continuous by-pass clarification of diesel lubricating oil is also dealt with in some detail.

In a recent book on chemical engineering unit operations[16] a chapter is devoted to centrifuges. The basic principles of separation are considered together with a mathematical treatment of the shape, volume and pressure of a liquid together with bowl stress and critical speeds in a simple centrifuge basket. Centrifugal filtration, liquid/liquid and liquid/solid separations are also dealt with.

Following the publication of this book it was noted by Hassett[17] that the equation derived by force integration quoted for the pressure developed in a liquid being centrifuged was not the same as that derived by pressure integration from another source. Experiments were made using a simple bowl suitably modified in which direct measurement of the pressure was possible. The experimental results confirmed beyond doubt the validity of the pressure integration derivation and subsequent correspondence,[18, 19] following the publication of this work, ultimately indicates the source of error which led to the investigation.

Other general matters encountered include a brief history of the development of De Laval bowls from the original hollow bowl, through tubular bowls to the present-day disc types,[20] a very extensive description of the manufacture of Broadbent basket machines[21] and the opening of a new laboratory for evaluating samples with a potential centrifuge application.[22, 23]

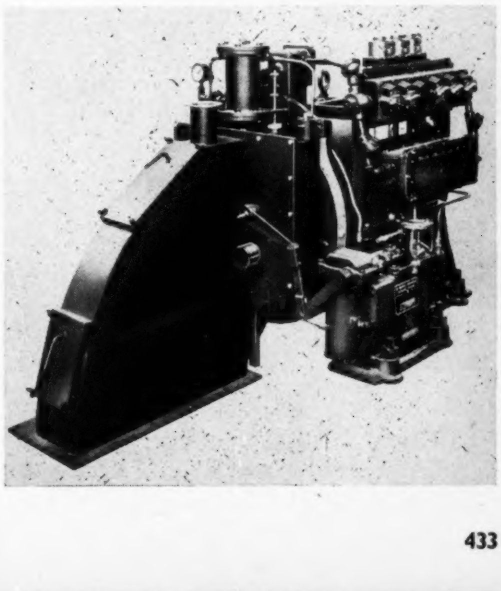
Laboratory machines and methods

The chief interest in this section is a new continuous laboratory separator designed to operate under pressure;[24] it is the Merco model PC9, operating at capacities up to 20 gal./hr. and developing a centrifugal force of 9,500 times gravity. A further multi-purpose machine is offered by the same company,[25] and both of these units can be used for scale up to production machines.

A laboratory model of the horizontal conveyor type *Dynocone* is also now available.[26] Full details have not been released yet, but it is understood that it is a true replica of the commercial machines and has a centrifuge bowl 6 in. in diameter.

A report from Achema XI[27] describes two new machines on show; one is designed to take 6 × 10 ml. tubes up to speeds of 17,000 r.p.m., and the other fitted with a refrigerated system for continuous operation at –26°C. Four further machines have been described,[28] comprising a 5-in. basket type with 300 ml. cake capacity, a larger model with 3 l. cake capacity

The Sharples vapour-tight 'Super-D-Hydrator' perforated basket centrifuge is suitable for separating, washing and dehydrating all types of coarse or fine crystals in a completely automatic and continuous manner. The vapour-tight construction is ideal for processing toxic or inflammable materials.



and maximum speed of 4,000 r.p.m., and two petroleum testing centrifuges for the I.P. and A.S.T.M. methods.

Particle size analysis by centrifugal means continues to receive attention;[29] the theory is discussed, existing methods are critically reviewed and a new technique is suggested for minimising errors inherent in these methods. The design and operation of a special rotor is described which forms the basis of the new technique, specifically developed for solids in which the majority have a particle size below 5μ.

Ultra centrifuges have been applied to the separation of the solids and liquid portions of mixed fats.[30, 31] Despite forces of 260,000 times gravity, the separation of the liquid phase from the solid phase was still incomplete. The liquid phase, however, was solid free and this later[32] enabled a dye dilution method to be developed for arriving at the true solids content of the mixture. A *Spinco* model E, developing 190,000 $\times$ gravity, has been used for studying the ammonium sulphate fractions of the protein from yellow lupin seeds.[33]

Other laboratory centrifuge uses include the isolation of plant starches,[34] determination of fat in cocoa products,[35] and the recovery of fat for peroxide tests for dairy products.[36]

New industrial machines and developments

A considerable number of new high-capacity De Laval separators have been developed over the last two years.[37] The majority are larger and more efficient versions of similar machines which have been proved in service over many years. For liquid/liquid or liquid/solid separations in which the solid content is below 0.5% there is a standard disc-bowl-type B 21020; this machine has 75% greater capacity than the largest of its precursors.

The unique range of De Laval hermetic machines has also been developed appreciably; these include types SSG/SRG 40970H and SSG 21470H machines for the De Laval *Short Mix* refining system, and TVG 40970H and TVB 21470H machines for the De Laval continuous soap process (*q.v.*, Part 2). In addition, the type BRH 21430H is the largest hermetic machine ever made, having a capacity more than three times the largest of the previous range. It has been developed primarily for the fine clarification of beer where the liquid is under pressure to avoid loss of carbon dioxide, and where the solid content is small, but it can be equally applied to any similar clarification problem where a brilliant liquor discharge is required. The machine has all liquid contact parts of stainless steel and requires a 15-h.p. motor.

The intermittent solid discharging machine type PX 20920S[38–42] has been mentioned already in these reviews, but a further new construction is now available, type BRPX 30930S. This machine is specifically designed for the beverage and similar industries where accessibility for thorough cleaning and sterilisation are essential. It is available as a liquid/solid separator only, where the solid content is up to 2%; a pressure discharge of liquid is arranged, and the machine has all liquor and sludge contact parts of high-grade stainless steel; a 15-h.p. motor is required.

For continuous solid discharge, the range of De Laval machines has also been extended considerably. For yeast separation a complete series of eight new machines are available. The basic type is the DX 20930 and the remainder are modified versions adopted for specific duties. The modifications include bowl speed, materials of construction, and machines for pressure discharge of the clarified wort. All these machines have capacities from 30 to 50% greater than those previously offered. They have been designed as the result of many years' association with yeast separation problems in which the requirements of every particular aspect of it are covered.

For solids concentration by recirculation of nozzle discharge there are three new De Laval machines, types QX 21030,[43] QX 21230 and QX 31230. They are all basically similar but differ in detail as to bowl speed and diameter, disc angle, and ' open ' and pressure discharge. They are intended for the separation of a wide variety of suspensions where the physical characteristics of the solid may vary appreciably, hence the flexibility in design to cope with the maximum variations. Capacities of up to 20,000 gal./hr. have been achieved on some problems and, depending upon the throughput, power consumption is 25 to 65 h.p. Two more specialised machines for starch production include the TX 21230 and TX 31030; these are basically similar to the QX machines referred to above, but they are not designed for recirculation. Instead they are arranged with an independent water feed to a special washing ring in the bowl to remove gluten adhering to starch during its separation within the bowl. Capacities up to 100 tons/hr. of starch milk are possible and they fulfil a much-needed requirement in the high-capacity starch plants of today.

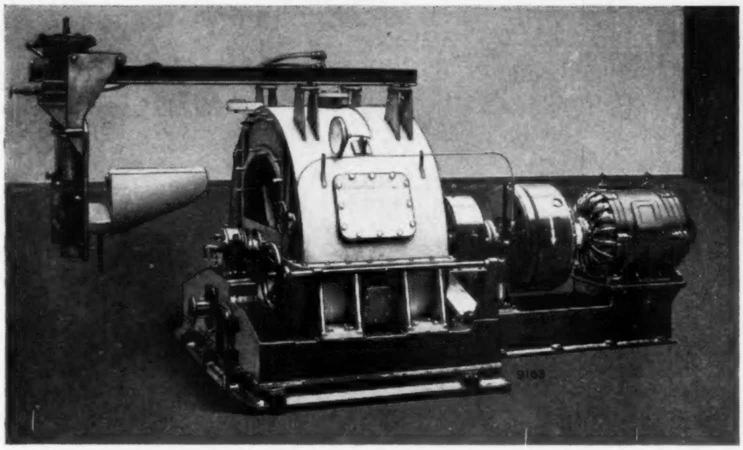
The latest addition to the De Laval range is the *Turbomatic*; this has a large-diameter inverted inclined bowl carrying a disc pack and rotating at 1,450 r.p.m. It is designed for efficient clarification of grinding coolants and similar materials in machine shops at capacities up to 2,200 gal./hr. and employs a reversing technique for sludge discharge from the bowl and does not therefore require manual cleaning.

A considerable amount of information on these new machines should be available from this source,[37] and it is to be hoped that it will be published in the not-too-distant future so that a better appraisal of the potentialities of the machines is available.

For the separation of abrasive catalyst from solvent solutions of polythene Merco[44, 45] have developed a new pressure centrifuge. The production model PC 30 is designed to operate at 100 p.s.i. and 300°F. at capacities of 90 to 250 gal./min. at a centrifugal force up to 4,000 times gravity.

Two new Podbielniak machines are announced; the *Chemizon*[46, 47] has a 42 in. $\times$ 42 in. rotor revolving at 2,000 r.p.m. with a liquid hold-up of 250 gal. It is a multi-stage centrifugal extractor offered for general chemical processing with a rated capacity of 500 gal./min. of combined feed and solvent. The *Phasezon*[48] utilises only the centrifugal separating features of the extractor without countercurrent mixing. The liquid velocity is low and the settling distance small, with the result that units are available with capacities up to 1,000 gal./min. and centrifugal force up to 5,000 times gravity.

Among the lower-speed machines are two continuous screen types for roughing-out operations. The *Mercone*,[49] which is also manufactured in Britain,[26] is intended for fibre removal in the starch and similar industries and consists of a rotating truncated perforated drum over which a helix rotating at slightly different speed moves the fibres downwards prior to discharge. Screen speeds can be 2,400, 2,800 or 3,200 r.p.m., for which 20 to 30 h.p. is required. The *Humboldt*[49, 50] is designed to dewater granular solids in the $\frac{3}{8}$ in. to 100 mesh range. By utilising a combination of centrifugal force and vibrating screen action, drier solids and constant discharge without mechanical devices are obtained, thereby avoiding undesirable grain size



This 60-in., ploughing-type, horizontal basket machine is designed for the separation of crystals and other types of solid where high capacity output is required. The machine can be arranged for fully automatic or semi-automatic operation and is available in different constructions depending upon the materials to be separated. (Watson Laidlaw & Co. Ltd.)

reduction and friction. Capacities of 70 to 80 tons/hr. of solid are claimed with power consumption of 0.5 h.p./ton of solids.

A fully automatic suspended basket machine for the chemical and food process industries is available,[51] and there is also a new machine for clarifying lacquers,[52] and a double-bowl vacuum centrifuge for clarifying and deaerating gelatine solutions.[53]

Patents cover a continuously operating perforated screen centrifugal with scraping and washing devices,[54] a single-stage push type with washing and automatic devices for feed density control,[55] a vertical multi-stage centrifuge, [56] liquid/solid separators,[57, 58, 59] continuously operating machines,[60, 61] and unspecified centrifugal separators.[62, 63, 64]

General details of new machines previously covered in these reviews include a Broadbent stainless-steel basket machine,[65] the Titan intermittent solid discharging machine as offered in America,[66] and the Sharples *Super-D-Hydrator*.[67] The latter is now also available in vapour-tight construction[68] and has considerable advantages when treating toxic or inflammable materials which can be processed in an inert gas atmosphere and under sterile conditions. Also new to Britain and designed for a specific purpose is the Sharples DHM *Nozljector*.[68] It is a disc-type recirculating nozzle machine intended for the purification of high-viscosity fuel oil; the nozzle discharge comprising water solids, and some oil, is recirculated until sufficiently concentrated to be discarded. The machine is available with the complete recirculating system comprising recirculating tanks, pump, strainers, valves, etc., which is so arranged to facilitate rapid dumping of the sludge.

Countercurrent extraction

There is growing evidence of the importance of centrifuges for liquid/liquid extractions and in particular Podbielniak machines are finding increasing favour for a number of duties. Chloromycetin and penicillin are solvent-extracted from broths containing solids; two models were used and information on design modifications, performance, and a cost comparison between filtration and extraction by this method is quoted.[69] Crude polymer is solvent-extracted to recover a monomer at a capacity of 950 gal./hr. The separation is somewhat incomplete, as the extract has to be gravity settled to remove some of the polymer, but this system of working considerably simplified an otherwise difficult extraction.[70] The *Petrozon* has been designed especially for the petroleum industry;[71] three 36-in. machines are incorporated in a new lubricating-oil refining plant using phenol extraction, but so far no operating details are available.[72]

Up to 12.5 theoretical stages of extraction have been reported for a Podbielniak machine with an acetic acid-hexone system[73] and 1.5 to 7.7 for a boric acid-isoamyl alcohol system using a series 5000 machine;[74] three to six stages are usual in regular operation.[75]

Other types of machines are also available for this system of extraction and brief descriptions of Luwesta and *Centactor* machines previously covered by these reviews have been reported.[76, 77] A patent[78] covers a system comprising a multi-stage mixing column with centrifuges at each end for separation of the extracted phases.

Petroleum products

The greatest outlet for high-speed centrifugal separators is undoubtedly their application to the separation of water and solids from petroleum oils, particularly in view of its increasing use in the modern world. The main types treated centrifugally are fuel and lubricating oils. In the case of fuel oil the accent is on the higher-viscosity residuals, particularly for marine diesel use[79] and numerous references continue to appear.[80] These invariably follow the well-established double-treatment system using two centrifuges in series for removing water and solids. For the initial separation De Laval PX 20910F self-discharging separators are finding favour in some cases,[81] but the majority continue to employ standard disc-type machines of the De Laval type. In one instance,[82] no less than ten large centrifuges are installed on board one vessel for the treatment of both fuel and lubricating oils; for flexibility and to cover all emergency conditions, self-discharging machines are also employed for lubricating oil purification.

A most detailed account of some experiences using centrifuged fuel oil and its effect in relation to engine performance and wear has been published,[83] and Lamb[84] has written an invaluable small book which includes a section devoted to the operation of centrifugal separators to this application. Nozzle-type centrifuges in series have also been applied to treating fuel oil for gas turbines;[85, 86, 87] in this instance a washing procedure is adopted to reduce the sodium content of the fuel and thereby reduce corrosion and slag deposit to give greater turbine efficiency. Such a system will probably be quite satisfactory for land installations, but in view of the processing requirements and complication of nozzle centrifuge operation it is doubtful whether it will find favour for marine use where simplicity of operation is essential.

An invaluable series of articles by Ellis covers present-day practices for the reclamation of used oils. Part 3[88] deals in a simple way with the principles and developments of a centrifugal bowl and goes on to describe the Bird continuous horizontal solid-bowl machine, De Laval disc bowls and

Sharples tubular bowls. The application of high-speed machines to diesel crankcase and detergent oils is then dealt with, together with the clarification of oils used for motor engine running-in operations on a test bed. Part 4[89] covers the removal of water and sludge impurities from insulating oils by the De Laval high-vacuum centrifuge unit and Part 5[90] deals with cutting oils and coolants. Combined units of perforated basket and high-speed centrifuges are used for the reclamation of coolants from swarf and a settling and centrifuge system is described for low outputs. The continuous centrifugal clarification of paraffin in a centralised system for washing machine parts is also dealt with.

Bailey[91] has also contributed a useful article on the centrifugal treatment of fuel and lubricating oils. The double treatment of fuel oil for marine purposes is dealt with and some interesting analytical results are quoted showing the effect of repeated centrifuging. Continuous by-pass centrifuging of crankcase and turbine oils is also discussed. Other references include the advantages of centrifugal treatment of lubricating oils in service[92] and lubricating oil treatment in a steel rolling mill.[93]

The search for crude oil sources continues, and there have been some further developments[94-97] in the centrifugal recovery of oil from tar sands. The actual design of the separator has not been disclosed, but the process, which gives a 98% yield, consists of mixing the sands with a light oil and forcing the mixture through a water layer in the centrifuge bowl. Other references to crude petroleum include the separation of light solids in weighted drilling muds using a conveyor-type horizontal centrifuge;[98] a centrifuge technique as a means of predicting the gravity drainage curve of a reservoir;[99] a method for evaluating detergents for petroleum displacement;[100] and a method for solvent extraction of cores.[101] Refining operations include an interesting account by Brown[102] covering liquid paraffin and white oil production. This employs a multi-stage centrifuge system for the separation of acid sludge from the stock after oleum treatment, and the subsequent separation of sulphonates after neutralising the residual organic acidity. A double-centrifuge treatment is also employed in the recovery of oil from refinery wastes.[103] Two patents[104, 105] cover processes for centrifuging wax from oil and solvent, and the dewaxing of lubricating oils.

REFERENCES

1 J. O. Maloney, *Ind. & Eng. Chem.*, 1956, **48** (3), 482.
2 *Idem, Ibid.*, 1955, **47** (3), 517.
3 *Chem. Engg.*, 1955, **62** (6), 175-238.
4 J. C. Smith, *Ibid.*, 177.
5 J. E. Flood, *Ibid.*, 217.
6 E. Molley and E. Carr, 'Fluid Handling,' pp. 95-130. George Newnes Ltd., London, 1955.
7 G. A. Frampton, *Ibid.*, p. 95.
8 D. G. Gillies, *Ibid.*, p. 106.
9 E. Ruegg, *Ibid.*, p. 123.
10 M. E. O. Trowbridge, *Brit. Chem. Engg.*, 1956, **1,** No. 2 (6), 68.
11 H. Trawinski, *Chemische Ing. Technik*, 1954, **26,** 189.
12 W. J. Podbielniak *et al.*, *J. Am. Oil Chem. Soc.*, 1956, **33** (6), 24.
13 M. M. Haruni, K. H. Todhunter and J. A. Storrow, *Chem. Engg. Science*, 1954, **3,** 87.
14 H. S. Dombrowski and L. E. Brownell, *Ind. & Engg. Chem.*, 1954, **46** (6), 1207.
15 N. E. Bergner, *Trans. Inst. Chem. Engrs.*, 1957, **35** (3), 181.
16 J. M. Coulson and J. F. Richardson, 'Chemical Engineering,' Vol. 2, pp. 453-477. Pergamon Press, London, 1955.
17 N. J. Hassett, *Chem. & Ind.*, 1956, (35), 917.
18 S. Hill, *Ibid.*, (42), 1214.
19 J. Ward, *Ibid.*, (52), 1521.
20 J. F. Jupp, *Canadian Chem. Processing* 1953, **37** (10), 34, 37, 38.
21 *Welding & Metal Fabr.*, 1954, **22,** 362.
22 *Scientific Lubrication*, 1956, **8** (11), 25.
23 *Lab. Practice*, 1957, **6** (2), 120.
24 *Chem. Engg.*, 1956, **63** (12), 268.
25 *Food Engg.*, 1954, **26** (2), 102.
26 International Combustion Ltd., Derby.
27 CHEMICAL & PROCESS ENGINEERING, 1955, **36** (7), 263.
28 *Ibid.*, 1957, **38** (7), 301 (Ref. CPE 650).
29 J. K. Donoghue and W. Bostock, *Trans. Inst. Chem. Engrs.*, 1955, **33,** 72.
30 N. N. Hellman *et al.*, *J. Am. Oil Chem. Soc.*, 1955, **32** (2), 73.
31 *Ibid.*, 110.
32 H. F. Zobel *et al.*, *Ibid.*, (12), 706.
33 W. E. F. Naismith, *J. Science of Food & Agr.*, 1955, **6** (11), 721.
34 F. B. Johnston, *Nature*, 1956, **178,** 370.
35 J. Kleinert, *Revue-international. chocolat*, 1955, (10), 302.
36 *Austr. J. Dairy Tech.*, 1955, (10), 72.
37 Alfa-Laval Co. Ltd., Brentford, Middlesex.
38 CHEMICAL & PROCESS ENGINEERING, 1957, **38** (2), 60.
39 *Food Manufacture*, 1957, **32** (4), 177.
40 *Chem. Processing*, 1957, **3** (4), 15.
41 *Chem. Age*, 1957, **77,** No. 1966 (3), 465.
42 *Brit. Chem. Engg.*, 1957, **2** (4), 220.
43 CHEMICAL & PROCESS ENGINEERING, 1955, **36** (9), 336.
44 *Chem. Engg.*, 1956, **63** (11), 108.
45 *Ibid.*, (12), 268.

In Part 2 of this article the author will go on to discuss applications of centrifuges in various industries including vegetable oil refining, animal fat production, soap, sugar, chemicals, food and dairy industries etc.

46 *Chem. Engg. News*, 1955, **33,** 3618.
47 *Chem. Engg.*, 1955, **62** (12), 256.
48 *Ibid.*, 1957, **64** (5), 204E.
49 *Ibid.*, 1956, **63** (1), 242.
50 CHEMICAL & PROCESS ENGINEERING, 1955, **36** (7), 264.
51 *Ind. & Eng. Chem.*, 1956, **48** (10), 121A.
52 *Fette und Seifen*, 1953, **55,** 108.
53 *Chem. Engg. Prog.*, 1955, **51,** 415.
54 Brit. Pat. 725,626.
55 Brit. Pat. 720,919.
56 U.S. Pat. 2,665,061.
57 U.S. Pat. 2,688,405.
58 U.S. Pat. 2,710,718.
59 U.S. Pat. 2,711,854.
60 U.S. Pat. 2,685,370.
61 U.S. Pat. 2,727,629.
62 U.S. Pat. 2,688,437.
63 U.S. Pat. 2,686,595.
64 U.S. Pat. 2,683,562.
65 *Manufacturing Chemist*, 1955, **26,** 253.
66 *Chem. Engg.*, 1956, **63** (7), 25.
67 *Fluid Handling*, 1955, **1,** 26.
68 Sharples Centrifuges Ltd., Camberley, Surrey.
69 D. W. Anderson and E. F. Lau: *Chem. Engg. Prog.*, 1955, **51,** 507.
70 *Chem. Processing*, 1955, **1** (8), 4.
71 *Pet. Engg.*, 1955, **27** (5), C49.
72 *Chem. Engg.*, 1956, **63** (5), 108.
73 M. Alexandre and P. Gentilini, *Rev. de l'Inst. francaise de petrole*, 1956, **11,** 389.
74 F. M. Jacobsen and G. H. Beyer, *J. Am. Inst. Chem. Engrs.*, 1956, (2), 283.
75 E. Gaden, *Chem. Engg.*, 1957, **64** (5), 237.
76 H. R. C. Pratt, *Indus. Chem.*, 1954, **10,** 475.
77 *Chem. Processing*, 1955, **1,** 10.
78 Brit. Pat. 699,133.
79 *Motor Ship*, 1955, (6), 93.
80 *Ibid.*, 1955, (1), 406; (7), 168; (8), 194; (10), 288, 303; (11), 332; (12) 376; 1956, (1), 440; (8), 172; (9), 224; (11), 300, 313; 1957, (1), 410; (6), 98.
81 *Ibid.*, 1955, (6), 93, 110; 1956, (10), 252; (11), 290; 1957, (5), 63.
82 *Ibid.*, 1957, (5), 57.
83 H. F. Jones, D. Royle and R. G. Sayer, *Trans. Inst. Marine Engrs.*, 1955, **67** (2), 37.
84 J. Lamb, 'Petroleum and Its Combustion in Diesel Engines,' pp. 122-163. Charles Griffin & Co. Ltd., London, 1955.
85 B. O. Buckland, *Ind. & Engg. Chem.*, 1954, **46** (10), 2163.
86 D. M. Landis, *Power*, 1955, **99** (7), 78.
87 *Oil Engg.*, 1955, **23** (268), 242.
88 E. G. Ellis, *Scientific Lubrication*, 1954, (12), 19.
89 *Ibid.*, 1955, (1), 12.
90 *Ibid.*, (5), 19.
91 C. L. Bailey, *Marine Engr. & Naval Architect*, 1955, (7).
92 A. M. Craig, *Scientific Lubrication*, 1956, (2), 30.
93 *Ibid.*, 1954, (10), 15.
94 *Chem. Engg.*, 1955, **62** (2), 104.
95 *Ibid.*, (6), 130.
96 F. J. Gardner, *Oil Gas J.*, 1957, **55,** 185.
97 *Pet. Times*, 1957, **61** (3), 201.
98 R. A. Bobo, *J. Pet. Tech.*, 1954, **6** (4), 39.
99 J. W. Marx, *Ibid.*, 1956, **8** (4), 88.
100 H. N. Dunning, Lun Hsiao and R. T. Johansen, *Indus. & Engg. Chem.*, 1955, **47** (10), 2147.
101 F. R. Conley & D. B. Burrows, *J. Pet. Tech.*, 1956, **8** (10), 61.
102 T. F. Brown, *Inst. of Petr. Rev.*, 1955, **108** (9), 314.
103 *Chem. Engg.*, 1955, **62** (3), 130.
104 U.S. Pat. 2,668,141.
105 German Pat. 917,864.

Success for Anti-corrosion Campaign

DISTINGUISHED CHEMICAL ENGINEERS AT LONDON GATHERING

TUESDAY, October 15, will be remembered as the day when, at a dinner at the Waldorf Hotel, London, some 300 people, including a large proportion engaged in chemical and chemical engineering industry, research and education, rose to their feet and pronounced a solemn curse on corrosion.

The occasion was the official dinner of the Corrosion Convention and the call for ' a curse on corrosion ' came from Sir Hugh Beaver, K.B.E., president of the Federation of British Industries, and even better known to readers of CHEMICAL & PROCESS ENGINEERING as president of the Institution of Chemical Engineers. He drew a parallel between the problem of corrosion and that of air pollution and recalled how the air pollution investigators, when faced with an overwhelming mass of available data relating to air pollution problems, had learned that progress could best be made by concentrating on a number of well-defined objectives. The same policy might well be adopted with success where the fight against corrosion was concerned.

At the Corrosion Exhibition: Mr. Harmar Nicholls (second from right) is seen here with Mr. W. Leonard Hill, chairman of the Leonard Hill Technical Group. Next to Mr. Harmar Nicholls' secretary is Mr. Bath of the Building Industries and Materials Division of the Ministry of Works, while on the extreme left is Mr. W. G. Norris, Leonard Hill managing director.

Sir Hugh was proposing a toast following a speech by Mr. Harmar Nicholls, M.P., Parliamentary Secretary to the Ministry of Works, who had earlier presided over the official opening of the Corrosion Exhibition at the Royal Horticultural Society's Old Hall, Westminster. Mr. Harmar Nicholls' speech at the dinner, in which he stressed the national significance of corrosion, was preceded by a toast to ' The Queen ' proposed by Mr. W. Leonard Hill, chairman of the Leonard Hill Technical Group—the organisers of the Corrosion Convention and Exhibition and publishers of ' C.P.E.', *Corrosion Technology* and 13 other industrial and technical journals.

Deep satisfaction that the anti-corrosion campaign had commanded the sympathetic attention and support of the distinguished representatives of Government, science and industry who were present at the dinner was expressed by Mr. W. G. Norris, managing director of Leonard Hill Ltd., who went on to enumerate some of the special distinctions of the chief guests and to point out their connections with the fight against corrosion. He paid tribute to Sir Hugh Beaver as one who has displayed exceptional talents in engineering, the Civil Service, and now industry. On a national scale Sir Hugh's greatest contribution to corrosion control must be his chairmanship of the Committee on Air Pollution, for the extension of smokeless zones under the Clean Air Act would greatly reduce the aggressiveness of industrial atmospheres and would help in saving buildings and structures from rust and decay.

After referring to Sir Hugh's office as president of the Institution of Chemical Engineers, Mr. Norris bid a welcome to Prof. D. M. Newitt, D.SC., F.R.S., as a distinguished past-president of the Institution who was also present. ' Prof. Newitt's consistent championship of the cause of chemical engineering places the profession and industry in general in debt to him,' Mr. Norris said. ' We in Leonard Hill have long experience of his kindness. His friendship dates back many, many years to the first publication of this House, the *Chemical Engineering Catalogue*, and for a time he was a valued collaborator of Mr. Leonard Hill.'

Representing the industrial side of chemical engineering was Dr. E. H. T. Hoblyn, M.B.E., director of the British Chemical Plant Manufacturers' Association, who has done notable work for chemical engineering education and research, while another well-known chemical engineer present was Mr. George Brearley, director of the Association of British Chemical Manufacturers. Coupled with the welcome to the members of the Scientific Civil Service who were present was the name of Mr. E. W. S. Press, Director of Chemical Inspection, Ministry of Supply. Mr. Norris pointed out that the Chemical Inspectorate, as well as controlling the chemical quality of some 2,000 Service stores, is intimately concerned with paints and runs the country's biggest outdoor paint-testing establishment at Glascoed, South Wales. Among other guests were Mr. E. G. Sangster, general secretary

of the National Paint Federation, Mr. K. S. London, president-elect of the Incorporated Plant Engineers, Mr. D. Cherry Paterson, past-president of the Mechanical Handling Engineers' Association and a pioneer in the development of efficient materials-handling equipment, and a great many other familiar names from the chemical, petroleum, metallurgical, engineering and other fields.

The Corrosion Exhibition, which was the subject of an illustrated preview in our special 'Corrosion Issue' last month, was an immense success and did much to bring together the latest solutions to the problems of corrosion. Equally successful was the two-day Corrosion Convention held at the Central Hall, Westminster, which was very well attended and at which some important points were made about corrosion problems not only in the 13 authoritative papers which were presented but also in the discussion which they engendered. Abstracts of some of the papers are given below.

Corrosion Convention

At the Corrosion Convention a number of authoritative papers were presented and keenly discussed. Here are some of the points raised.

PROTECTION OF PLANT AND EQUIPMENT IN THE PETROLEUM AND CHEMICAL INDUSTRIES

By H. B. FOOTNER, B.Sc., Ph.D., A.R.I.C.
(*Shell Petroleum Co. Ltd.*)

(*Paper delivered on Tuesday, October* 15)

THE topics treated include the internal and external protection of steel structures, tanks and pipelines, with an account of the lining of drums. In his introduction, the author deals with the reasons for applying protective coatings in the oil and chemical industries and goes on to enumerate the factors which cause corrosion. Each of these is expounded in detail.

External painting of steel structures

Storage tanks represent the largest superficial area subject to corrosive influences. The practice is to use the same system of protection in all conditions of exposure. Sad experience has taught that descaling and priming at the manufacturer's premises is essential for success. In the U.S. sandblasting after installation is extensively used. The choice of procedure is largely governed by economic considerations.

Various phenomena, heat reflectance, chalking and chemical attack, are considered in relation to the choice of the best pigments and media available for use in the painting system. The importance of the thickness of the coating is emphasised. It is clear that many users are experimenting with the newer epoxide-based resins.

Internal treatment of tanks

Chemical attack is sometimes caused by materials which are not normally corrosive. In this application also the thickness of the protective coating is of importance. Evidence is presented that many different kinds of coating materials are being tried.

Pipelines

Coal-tar pitch or bitumen remain the favourite substances for the external protection of pipelines, in spite of much experimentation with other materials. The procedure used in the application of the coating has a very decided influence on the duration of the protection. Cathodic protection is coming into more general use.

Internal treatment of pipelines raises very many difficult problems. Preventive methods include: inhibition by injection of chemicals, lining with cement, galvanising, resin based linings. Each of these is discussed and recent developments are reported, particularly *in situ* cleaning.

Lining of drums

Until recently the most satisfactory medium was a phenolic resin. Now a phenolic modified epoxide type resin is showing some advantages. Several other types of coating are being investigated, some of these offering promise of good results.

With accumulating experience of the effects and results of corrosion, the causes are becoming clear; knowing the causes and bearing environmental factors in mind, the proper remedies can be enunciated and put into effect. The new materials which are being employed show that there is no tendency to complacency among those who fight against corrosion.

Corrosion Convention Proceedings

All 13 papers read at the Corrosion Convention will be published, together with the ensuing discussions, as a book entitled 'The Proceedings of the Corrosion Convention.' It is hoped that the book will be available early in 1958. It will cost one guinea—post free.

As it is anticipated that there will be a heavy demand for these proceedings, intending purchasers should immediately send their orders, together with a remittance for one guinea, to the publishers, *Corrosion Technology*, Leonard Hill House, Eden Street, London, N.W.1.

SELECTION OF CORROSION-RESISTANT METALS AND ALLOYS

By J. B. COTTON, A.M.C.T., A.R.I.C.
(*I.C.I. Metals Division, Research Department*)

(*Paper delivered on Wednesday, October* 16)

RESISTANCE to corrosion is not the first factor affecting choice of materials; mechanical properties, ease of fabrication, and heat transfer efficiency often override deterioration. New materials are always being evolved and the task of selection for a particular application becomes onerous. But before embarking on selection it is necessary to consider two aspects of the rate of corrosion: (1) contamination of product and (2) durability of plant. The difficulties that arise in assessment of these two phenomena are dealt with.

Principles of selection

Some metals are intrinsically less subject to corrosion—for example, the noble metals. Others form protective films, but these films are so dependent on environmental factors that these must, in each instance, be carefully considered.

Oxygen itself may either cause or suppress corrosion. The deciding circumstances are discussed and results given of many experiments designed to give data of corrosion rates of various metals in oxidising environments. The unusual properties of titanium are outlined.

Examples are quoted to show that temperature effects can be predicted but that acid strength frequently leads to an unforecastable result which can only be discovered by trial and error.

Stagnant liquids in chemical plant lead to trouble due to settling of particles which may cause attack and also due to depletion of the metal oxide film. But excessive speeds in moving liquids may cause erosion or give rise to impingement effects.

Solubility of corrosion products

The well-known example of protection is the formation of insoluble lead sulphate which enables lead to withstand corrosion by sulphuric acid. Lead acetate is very soluble, hence dilute acetic acid rapidly attacks the metallic lead. Similar examples with other metals have been reported.

Influence of contaminants

Stress corrosion cracking may be started by traces of contaminants in an otherwise pure stream of fluid. Traces of other materials may exert an inhibitory effect. Although a trace of moisture is essential for many chemical reactions, it can have disastrous corrosion effects.

Assessment and testing

The author recommends that, even after all the above factors have been given due consideration, advantage should be taken of the experience of others as recorded in the growing literature of the subject. A number of useful references is quoted. When a selection has been made of the material intended to be used, corrosion testing should be undertaken because this is the best method of ensuring trouble-free plant operation. The mode of procedure is outlined.

Conclusion

The most effective use of corrosion-resistant materials is made when they are chosen in conjunction with advances which are continually taking place in the forms in which cast and wrought metal are produced. Advances in brazing and welding techniques also assist in producing more efficient chemical plant.

VINYL RESINS IN THE CONSTRUCTION OF CHEMICAL PLANT

By W. E. MARTIN, B.Sc.
(*BX Plastics Ltd.*)

(*Paper delivered on Wednesday, October* 16)

THESE materials, with resistance to chemical attack very superior to the conventional metals, have been in use for over twenty years. The bulk of the PVC resin used to combat corrosion is in the plasticised form. The use as constructional material of the harder, unplasticised resin follows from its properties and their implications in the methods used for fabrication.

Resistance to attack

Shear strength has been found to be the most reliable measure of the effects of plasticisers, small additions of which cause large changes in the resistance to chemical attack. In attempts to evaluate the usefulness of these resins, the nature and scale of this attack has been studied. Another method of modifying PVC is by the formation of co-polymers, in some of these apparently, little variation of the corrosion-resisting properties of the original resin is induced.

The recent introduction of metal reinforcing has raised the safe temperature from the generally recognised level of 60°C. to as high as 120°C., necessitating revision of many of the methods of testing and evaluating the resins.

Manner of use

Commercially produced PVC polymer is a rather hard, white powder. In this form it finds little or no direct use in industry. In order to convert it into a useful form it has to be heated and worked mechanically until it becomes a tough dough-like material which can be formed into tubes and sections in extrusion machines and into sheet on calendering devices. Extrusion into rod, tube and sections is widely practised on a commercial basis. In Germany, extensive use has been made of PVC in the form of piping. Relatively slow progress has been reported from Great Britain and the U.S.A.; this is due to some extent to difficulties experienced in finding suitable means for jointing. Sheet form has achieved much more general popularity in the lining of tanks and ducting. The main cause of failure in use in this connection is weakness or lack of homogeneity in the welds. The newer forms being introduced, including sheet glued to hardboard or metal laminates, remove the possibility of catastrophic shattering, the most important single disadvantage of unplasticised PVC resins.

Working methods

Comprehensive data are available on machining and shaping rigid PVC, but one point must be emphasised, it can only be fabricated at between 110°C. and 120°C. For design purposes it can be taken that an average welded join has about 65% strength of the sheet material. Welds up to 90% can be obtained, and it can also go as low as 30% without being obviously bad. PVC can be conveniently drawn, but chiefly it is used for constructional purposes in the same manner as steel sheet. For lining tanks and ductings, it can be rolled on or glued. Gas welding is slow and success has been achieved in some cases with high frequency welding.

Illustrations

Lantern slides illustrated some of the uses to which the material has been put in electro-plating, textile, papermaking and shipbuilding industries.

METAL AND PLASTICS COATINGS

By G. H. JENNER, B.Sc.
(*Schori Division, F. W. Berk & Co. Ltd.*)

(*Paper delivered on Wednesday, October* 16)

Metal powder

THE two principle methods of spraying metals are the powder process and the wire process. In the former, powder is supplied to the gun, from a separate unit, under pressure. The powder is plasticised by passing through a flame, thus enabling it to adhere to the surface being treated. The pressures of the gases used are regulated by a control panel, which also regulates the correct amount of gas, powder, and the nature of the flame, giving correct spraying conditions. On releasing the pistol hand-grip the powder supply is shut off and only a pilot flame remains.

Metal wire

In the wire process wire fed into a gun is atomised into small droplets by the flame, which on striking the metal surface adhere as in the powder process. The fuel gases are conveyed under pressure *via* reducing valves, the mixture and the correct flame being regulated on the pistol. A white flame is normally used, too much oxygen producing a blue flame and too much fuel gas a red flame, both of which will slow down the spraying speed.

Preparation

Before treatment, the metal surface must be free from grease and slightly roughened, the latter being carried out by shot blasting or sand blasting using crushed steel grit or crushed flint sand. There are three principal types of machine for shot blasting: pressure blasting or open nozzle blasting, centrifugal or airless blasting, and vacuum blasting.

In open nozzle blasting, varying grades of crushed steel grit are used according to the heaviness of the rust deposit.

Centrifugal blasting, used for small objects, incorporates a wheel rotating at high speed, on to which the abrasive is fed, causing the abrasive to be thrown on to the work being cleaned.

Vacuum blasting is a new technique similar in principle to open nozzle blasting with the difference that when the shot has hit the metal surface it is withdrawn into the vacuum pipe.

Zinc and aluminium

The metals most commonly sprayed are zinc and aluminium, to give protection against corrosion on the same principle as galvanising. Whereas the protective action of zinc when applied to iron or steel is sacrificial, aluminium coatings protect by sealing off the steel with its very tenacious oxidisation products. Sulphur dioxide in the atmosphere, which destroys zinc coatings relatively fast, will assist the formation of this coating with aluminium.

Since metal sprayed coatings are normally about 10% porous, it is essential that they corrode preferentially to iron and steel. Experiments have been tried using fluxes such as boron carbide with the metal powder in the flame to break down the surface tension of the hot metals, so achieving the flowing of one globule into another.

Plastics coatings

Plastics coatings, produced by replacing the powdered metal used in metal spraying by certain powdered plastics, are finding an increasing use in industry. They can be applied to complicated surfaces where it would be very difficult to fabricate a suitable liner and, especially in the case of polythene, have better adhesion than liners.

Articles to be completely enveloped in a plastic need a minimum of surface pretreatment; usually confined to surface degreasing. Articles not to be completely enveloped usually require a degree of sand or grit blasting. It is then heated to a temperature slightly higher than the melting point of the plastic, so melting, without degradation, the powdered plastic. Alternatively, the plastics coating can be applied by flame spraying in a similar manner to metal spraying.

Range of plastics

Plastics which may be applied by the methods detailed include: polythene, nylon 'R,' *Thiokol*—a synthetic rubber, shellac, and epoxy resins such as *Araldite*. Special grades of these plastics are manufactured for powder spraying.

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ANTI-CORROSION COATINGS FOR BURIED PIPES

By W. D. PARKER, B.Sc., F.R.I.C., and A. G. WILKIE, A.R.I.C.
(*Winn & Coales Ltd.*)

(*Paper delivered on Wednesday, October* 16)

THE most serious form of pipe corrosion in Britain occurs in waterlogged clays and arises from the activity of anaerobic sulphate-reducing bacteria. Sometimes deterioration is very rapid, almost invariably because of failure to provide a proper preventive system.

The main types of coating used for the protection of gas, water and sewage pipes are hot-applied bituminous and petrolatum or grease-coated tapes. Pressure-sensitive polyvinyl chloride tapes have also been used but no conclusions have been drawn as to their durability. The coated tapes are generally based on a petrolatum compound which is impregnated into and coated on a fabric. They can be easily applied, as no heating is needed, even in cold weather. Petrolatum-based wrappings retain their greasy quality indefinitely and re-adhere if displaced. Adequate mechanical protection can be provided by a supplementary wrapping of bituminised hessian or glass fibre or by using a coated tape laminated to a film of polyethylene or PVC which forms a protective outer sheath. Coatings should be able to protect a surface which is already covered with an oxide film; when a petrolatum coating is applied, corrosion rate may be reduced by the enveloping effect of the colloidal fibres. A petrolatum-based coating, by virtue of its soft, inert character will maintain its protective properties indefinitely, providing there is no mechanical imperfection when the pipe is buried; it is chemically

stable, and resistant to sulphate-reducing bacteria (though under exceptionally aggressive conditions a 55% overwrap is advised).

Tests have been made on the resistance of petrolatum-based coatings to sulphate-reducing bacteria which indicate that it would be beneficial to incorporate a mangrove tannin extract in a petrolatum-coated tape. During electrical resistance tests petrolatum coatings with PVC and nylon backings gave the highest final resistance while a similar coating on cotton cloth showed very slight incipient corrosion.

Conclusions drawn from burial tests under an impressed positive potential were that petrolatum-coated tape with PVC backing gave the best protection and was superior to petrolatum coated on either cotton cloth or glass tissue with a bitumen coating or overwrapping.

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CORROSION IN THE ATOMIC ENERGY INDUSTRY

By M. D. JEPSON, M.Sc., Ph.D., A. I. M., D. WHITE, A.I.M., and L. HARBOURNE, B.Sc.
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(*Paper delivered on Tuesday, October* 15)

IN general the problem of corrosion in the atomic energy industry is the same as in any other handling corrosive liquids, high pressure gases, steam and water, but complicated by the need to protect from radioactivity and some limitations on the choice of materials. Some particular problems are discussed.

The uranium extraction process involves nitric/sulphuric acids and hydrogen fluoride. Where maintenance is possible an 18/8/Ti steel is used. Where activities are high and the material inaccessible, an 18/13/Nb steel is selected. Micro-cracking on welding was avoided by using a weld containing ferrite. Accelerated corrosion was observed in tests (800-hr. boiling nitric acid) in the presence of hexavalent chromium, V^{v}, Ce^{iv} or Ru^{viii}. The last two are present in post-irradiation processing, but accelerated corrosion did not occur in practice, possibly due to irradiation from fission products reducing the oxidation potential.

Uranium hexafluoride (used to separate U_{235} and U_{238}) is highly corrosive. Here hydrogen fluoride accelerates corrosion, and in practice the initial high rate of absorption can be satisfied by fluorinating the plant before use.

The three types of reactor (CO_2, water or sodium cooled) present different problems. The fuel element cladding material needs special considerations to avoid weakening, penetration, transfer of radioactive material or reduction of heat transfer.

CO_2-cooled reactors use magnesium as the canning element. Pure magnesium, inert in dry CO_2, suffers pitting corrosion in wet CO_2. This is overcome in alloys with small qualities of beryllium, calcium and aluminium. Here the smaller beryllium ions reduce the rate of cationic diffusion in the oxide film. After discharge from the reactor, fuel elements are stored under water. Transgranular and grain boundary attack leads to pitting and the transfer of fission products. This has so far only been overcome by raising the *p*H of the water to 11 or more.

The pressurised water reactor usually uses a zirconium cladding. This has good resistance to high temperature water but is strongly influenced by trace impurities, particularly nitrogen. Zirconium has a two-stage corrosion process: a quasi-cubic law is followed to a 'breakaway' point forming an adherent black film, then the rate becomes constant and a white deposit is formed. *Zircalloy*, based on the binary zirconium-tin alloys, makes the stages reproducible and leaves the second-stage product adherent. The mechanism is believed to be that Sn^{3+} ions become associated with N^{3-} ions and O^{2-} vacancies and effectively reduce the number of O^{2-} vacancies.

The high fuel temperatures in highly rated, sodium-cooled reactors would produce reaction between metallic fuel and most constructional materials. Hence the refractory metals, niobium and vanadium are used, or a ceramic fuel. In liquid metal corrosion is not electrochemical. Problems which do arise, however, are (*a*) solution of the solid metal in the liquid and consequent mass transfer, and (*b*) formation of compounds of the solid metal with impurities in the liquid. Developments in the techniques of control of these factors made it possible to proceed with the Dounreay fast reactor.

The problems of the steam raising plant differ little from conventional practice, except at Dounreay, where stainless steel had to be used, and its stress corrosion problems arose. The methods of meeting this are described.

Other problems that have arisen are: to avoid the carrying of scale into the reactor, to avoid galvanic couples in the cooling ponds and the protection of equipment which requires repeated decontamination. The answers to these problems are also discussed.

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FUEL ADDITIVES IN THE FIGHT AGAINST CORROSION

By B. J. ZACZEK, Ph.D., D.I.C., A.M.I.Mech.E., and R. GRINDLEY, Ph.D., M.Sc.
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(*Paper delivered on Tuesday, October* 15)

ALTHOUGH atomic power is going to be supplied in the form of electricity at an increasing rate to satisfy demands for energy, the limitations, designs and inherent needs for protection restrict its field of usefulness to domestic and rail transport use.

Today the fuels available are coal, tar distillates and petroleum derivatives. The derivatives of petroleum consist of 82 to 87% carbon, 10 to 15% hydrogen, up to 6% oxygen, nitrogen, sulphur, and trace metals making up the balance.

Corrosion from fuels

After physical and chemical refining processes, crude petroleum yields substances which can be used as fuels and, depending on the mode of use, the requirements differ. Thus the internal combustion engine can consume gasoline, kerosene or diesel fuel, whilst the users of petroleum products for steam raising use heavy fuel oils. It is in the latter field that oil tends to replace coal particularly for generation of electricity, use in steel making, foundry and ceramics. In all the latter applications the plant in which petroleum products are burnt suffers from corrosion mainly due to oxides of sulphur. These in presence of water are extremely corrosive. Water will always be provided by the combustion of the hydrocarbons, and those parts of flues which are cooler offer condensation surfaces on which sulphuric acid forms. It should be noted that in the presence of SO_3 the moisture in flue gas will start condensing at about 200°C. Metallic sulphates which form at the same time affect slag formation.

Atmospheric pollution

Atmospheric pollution is yet another problem arising from the presence of various impurities in petroleum.

The problems have been approached from various angles, such as control of combustion, protective coatings and fuel additives. A great deal can be done by the use of the first two, bearing in mind that SO_2 is less corrosive than SO_3 and a limit to supply of excess air will tend to produce the former. The use of alkaline additives to the fuel achieves partial neutralisation of sulphuric acid, but they are liable to be displaced from the sulphate on the hot metal of the boiler.

Additives

The best method of addition of such alkaline compounds would be in the form of a liquid soluble in the fuel. Stearates and naphthenates have been tried, but bearing in mind the quantity of metal which has to be introduced to perform neutralisation they are rather expensive. Powdered additives which can be introduced in the form of a cloud into combustion chamber or flue duct or by means of injectors are rather more economical. In any case, the addition of such alkaline esters or carbonates must not be over-generous, so it becomes extremely important to measure the amount of SO_3 in the flue gas. A method of measuring devised by the Coal Utilisation Research Association relies on the rise of its dewpoint. Another method depends on the amount of corrosion caused in the flue on a probe inserted for a measured period of time. A definite improvement can be seen after the addition of a correct fuel additive.

There is another method which utilises drop of pressure along the route of the gases since SO_3 corrosion will result in build-up of obstructing material. The mechanism of action of fuel additives has not been definitely ascertained, since a great deal depends on completeness of combustion of the oil. Solvents in which the additives are entrained often improve the burning qualities of the fuel by lowering its viscosity. Metal soaps act as sludge dispersing agents. Bases neutralise the acidic combustion products. Some oxides and pure carbon will partly absorb the SO_3. Specific additives which are directed against metals found in crude, in particular V, work through the formation of vanadates.

In internal combustion turbines and in superheaters, the effect of corrosion is accentuated through an attack by V_2O_5. Here china clay, talcum and other inorganic substances produce beneficial effects.

On the whole it appears that the field is inadequately covered and there is room for a great deal of improvement.

> Other papers given at the Corrosion Convention and not dealt with here include: 'Corrosion in the Shipping Industry,' by S. R. Bew; 'Packaging to Prevent Corrosion in Transit and Storage,' by F. A. Paine and D. Watkinson; 'Corrosion and Water Treatment,' by G. G. Sindery; 'Paints and the Part They Play in the Fight Against Corrosion,' by H. Hollis and L. J. Coleman; 'Hot-Dip Galvanising,' by W. L. Hall; and 'Some Aspects of Cathodic Protection,' by W. Godfrey Waite.

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PAINTS AND THE PART THEY PLAY IN THE FIGHT AGAINST CORROSION

By H. HOLLIS, B.Sc., A.R.I.C., and L. J. COLEMAN

(Ministry of Supply Chemical Inspectorate)

(Paper delivered on Wednesday, October 16)

THE subject is dealt with under three main heads:

(1) Modern pigments and varnishes available for the formulation of anti-corrosive films.

(2) Reference to specific items to indicate how best to produce a satisfactory painting system.

(3) Factors which lead to premature breakdown of paint films; comments based on experience.

It is now generally accepted that corrosion is an electrochemical phenomenon, and the best preventive is to break the electrical circuit, which a paint film should do. The part played by careful preparation, allowing the film to do its work, is emphasised. Protective pretreatment should also be considered as an integral part of the painting procedure. New anti-corrosive pigments for use in primers are in continual development; red lead, chromates, calcium plumbate and zinc dust are selected for comment.

Finishing coats

In the formulation of primers we have an abundance of pigments, so in finishing coats there is a bewildering variety of media. Alkyds, phenolics, epoxide, urea and melamine and silicone resins receive special attention as do chlorinated rubber, cellulose and water-bound acrylic paints.

Selection of painting system

Reference is made to specific items of Service equipment where it would appear that epoxide resins are most favoured but not always chosen because of their relatively high cost. It must be borne in mind that Service equipment is frequently subjected to extremes of temperature and humidity for protracted periods. The painting procedures involved in ensuring adequate protection in such circumstances are necessarily more elaborate than could normally be considered by a commercial undertaking.

Causes of paint failure

The main causes are given as:

(1) Inadequate preparation of surfaces and of paints, prior to application.

(2) Inadequate maintenance of surfaces.

(3) Application unsatisfactory, or in unsuitable drying conditions. Paint manufacturers may rejoice to note that the authors attach little blame, very little, to the paints themselves. These three causes of failure are dealt with in some detail.

Conclusion

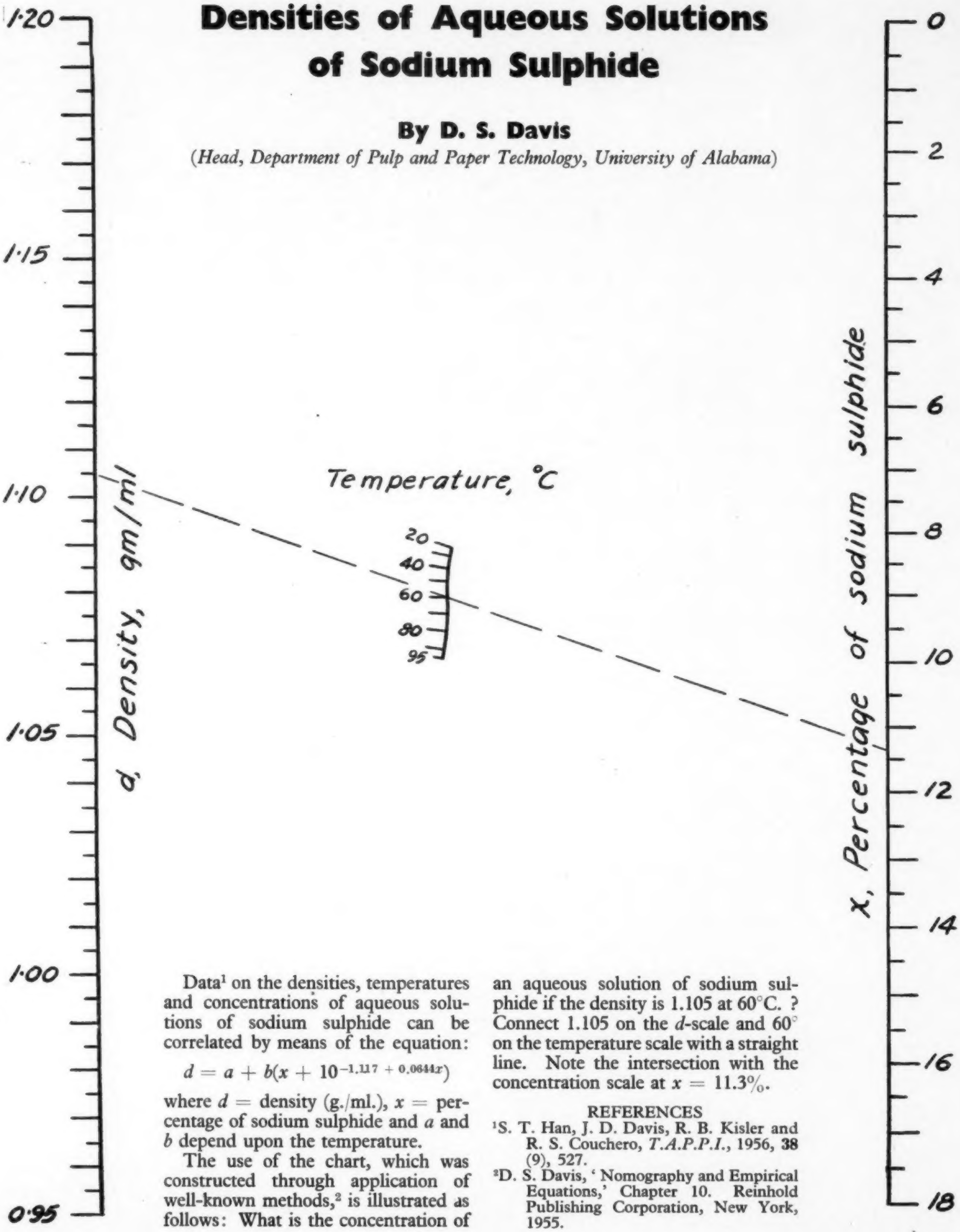
The paint manufacturer of today is a skilled craftsman with a wealth of raw materials, knowledge and experience at his disposal. He can often produce a material tailor-made for a particular job, but he has a right to expect that the customer will respond and will not impose additional restrictions associated purely with remediable unsatisfactory practices or shop conditions. Intelligent co-operation from both sides will produce finished articles with the best possible chance of withstanding the rigours of climate and industrial conditions.

Nomogram:

Densities of Aqueous Solutions of Sodium Sulphide

By D. S. Davis

(Head, Department of Pulp and Paper Technology, University of Alabama)



Data[1] on the densities, temperatures and concentrations of aqueous solutions of sodium sulphide can be correlated by means of the equation:

$$d = a + b(x + 10^{-1.117 + 0.0644x})$$

where d = density (g./ml.), x = percentage of sodium sulphide and a and b depend upon the temperature.

The use of the chart, which was constructed through application of well-known methods,[2] is illustrated as follows: What is the concentration of an aqueous solution of sodium sulphide if the density is 1.105 at 60°C. ? Connect 1.105 on the d-scale and 60° on the temperature scale with a straight line. Note the intersection with the concentration scale at $x = 11.3\%$.

REFERENCES

[1]S. T. Han, J. D. Davis, R. B. Kisler and R. S. Couchero, *T.A.P.P.I.*, 1956, **38** (9), 527.

[2]D. S. Davis, 'Nomography and Empirical Equations,' Chapter 10. Reinhold Publishing Corporation, New York, 1955.

Correct Selection of Drying Equipment

By Leo Walter, A.M.I.Mech.E.

After briefly discussing the considerations involved in the selection of a drier for a given duty, this article reviews a number of types of driers and their characteristics, and comments are made on their possibilities and limitations.

CORRECT choice of drying equipment for industrial purposes involves consideration of both economical and technical factors and practice shows that different drying methods sometimes produce the same desired result. Nevertheless, one drier might require more heat, more power for fan drives, etc., and more attention than another. Obviously the choice will in this instance fall on the more economical design.

Many surveys carried out by the writer have proved that two or three modern drier types can be used for the same product with obviously satisfactory results. Much depends on working conditions and on drier instrumentation in particular. It can be safely stated that in many instances plant management does not know, and does not care, much about the thermal and overall efficiency of a drying plant as long as satisfactory output is maintained. Plant people usually operate an existing drier in a more or less haphazard way, and only start worrying once trouble has started. The latter may consist in an uneven product, in fall of output, or in a complete breakdown of the drying equipment, or of part of it.

Selection of a new drying method or plant cannot, however, be based on reliability and easy maintenance alone, although this is an over-riding factor. Obviously, of two different but equally reliable driers the machine or plant with lowest operational costs, including fuel, power, labour maintenance, etc., at equal output will be preferable.

Classification of driers

A good classification of available drier types will facilitate correct selection of a given drier for a given job. The best classification should be based rather on material characteristics than on drier design groups and method of moisture evaporation used.

An excellent table for drier classification based on methods of heat transfer in evaporation of moisture is reproduced in the accompanying table with the permission of Keeney Publishing Co., of Chicago (see bibliography), and devised by W. R. Marshall, Jun., of the firm of Du Pont de Nemours. Although this table is concise and gives briefly drier characteristics for each type, the choice of a new drier to be specified is still a bewildering task when the investigating engineer is confronted with a multitude of various makes for each drier type, all of them similar but not quite identical.

Various methods are open for ultimate selection. Personal experience might definitely indicate a certain type and make. In another instance, visits of various factories where driers work to satisfaction for drying the same or a similar product might narrow down the eligible designs and makes. Sometimes drier characteristics match material characteristics to such an extent that a good choice is easy. In other instances, either for a new product or where highest efficiency is desirable, all theoretical or comparative considerations have to be abandoned in favour of actual practical tests on a pilot plant.

Heat flow and heat transference

Whether batch drying or continuous drying methods are applied, the basis of efficient drying is heat distribution, control of rate of heat input, heat transference from heating medium to the particles of the material to be dried, and the amount of moisture to be evaporated and to be driven out.

Because the efficiency of direct driers, such as hot-air or hot-gas driers, increases with rising inlet temperature of the drying air or gas when exhaust temperature remains fixed, the highest practical drying temperature should be used. Exhaust air should leave the drier at lowest possible temperature, but as fully saturated with moisture as possible. For lower-temperature drying, either vacuum can be used or artificial dehumidification of the inlet air. It should be borne in mind that driving out of the last percentages of moisture from a solid material, *i.e.* during the falling rate of warm air drying, is a most difficult and costly business. Exaggerated demands for dryness of the finished product have, therefore, to be paid for in every respect, and would be better abandoned.

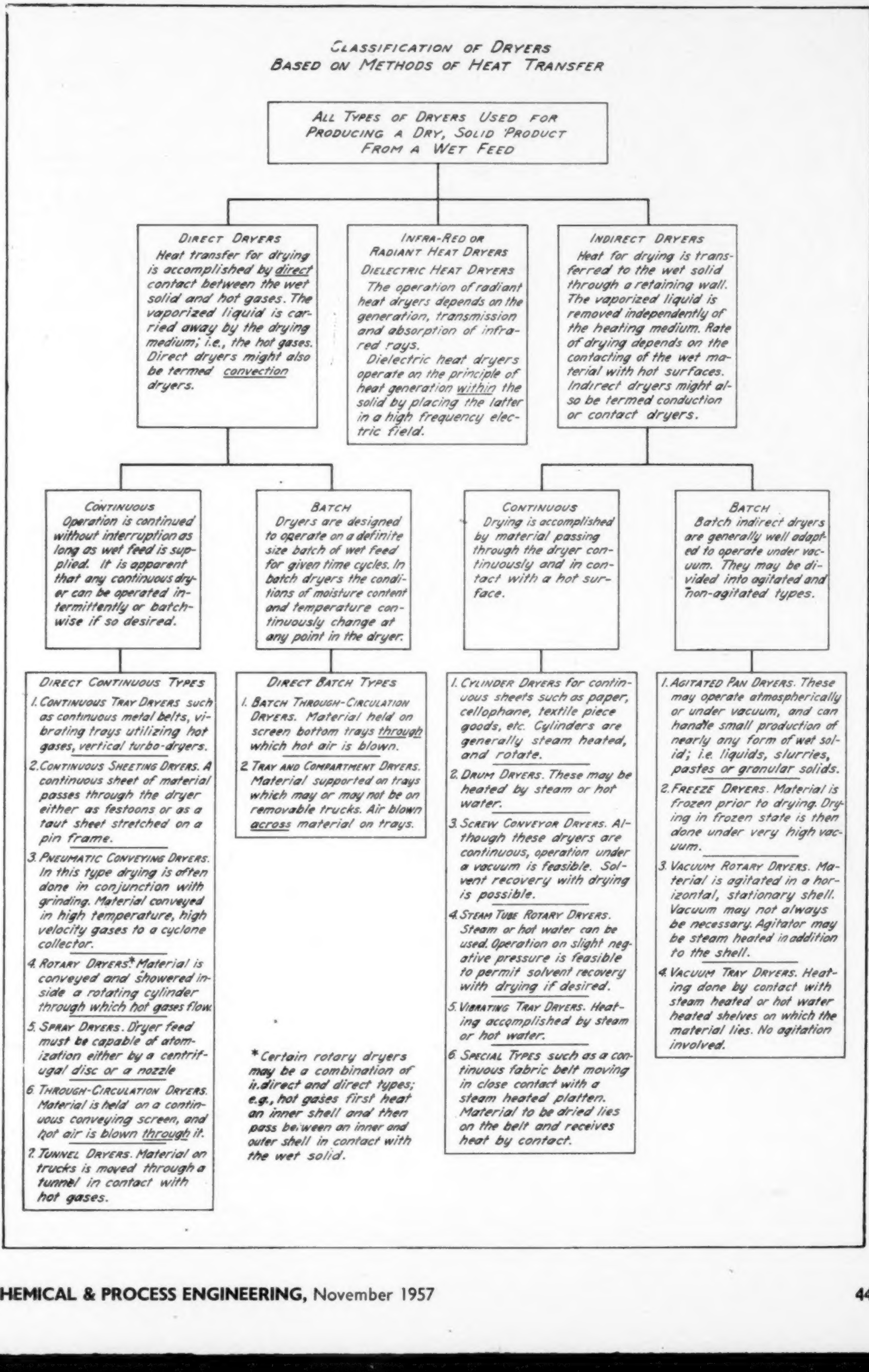
Indirect continuous driers

Modern indirect continuous driers are without doubt the most economical types in many instances. In general, an indirect drier can handle a greater load than a direct drier at comparable temperatures.

As no general ruling can be given for correct final selection of a drier type, a number of designs taken at random from practical experience are briefly discussed in the following.

Continuous multi-band conveyor driers consist of a tunnel through which pass several conveyors, or a single band in several layers. Gravity is used to move the stock from one band to the next (Fig. 1) until discharge takes place at the opposite lower end. In the vertical-type band drier (Fig. 2) the conveyors are placed in a tower and the material falls downward. Usually the hot air is admitted through a single point of inlet, either in concurrent or in counterflow. Short circuiting of air sometimes takes place, and reconstruction in the form of providing two or more separate hot-air inlets might improve output. Zonal recirculation, although desirable, is usually impracticable, but insertion of baffles might improve air and heat distribution.

Fig. 3 illustrates a falling-tray conveyor drier with a drying and a cooling zone, both separated by a baffle plate. For certain chemicals continuous-type driers were designed, consisting of a tower with shelves. Scraper bars rotate and make the material drop from tray to tray, or the whole tower rotates, against stationary scrapers. Fig. 4 illustrates a type with turbo fans and heater steam coils around. An improvement of the latter would consist in sectionalising the steam coil, thus providing better steam trapping with improved heat transfer. The wider use of glass windows and of sampling openings in the tower is also advisable. Of greatest importance is to watch


Classification of Dryers
Based on Methods of Heat Transfer
All Types of Dryers Used for Producing a Dry, Solid Product From a Wet Feed
Direct Dryers
Heat transfer for drying is accomplished by direct contact between the wet solid and hot gases. The vaporized liquid is carried away by the drying medium; i.e., the hot gases. Direct dryers might also be termed convection dryers.
Infra-Red or Radiant Heat Dryers
Dielectric Heat Dryers
The operation of radiant heat dryers depends on the generation, transmission and absorption of infra-red rays.
Dielectric heat dryers operate on the principle of heat generation within the solid by placing the latter in a high frequency electric field.
Indirect Dryers
Heat for drying is transferred to the wet solid through a retaining wall. The vaporized liquid is removed independently of the heating medium. Rate of drying depends on the contacting of the wet material with hot surfaces. Indirect dryers might also be termed conduction or contact dryers.
Continuous
Operation is continued without interruption as long as wet feed is supplied. It is apparent that any continuous dryer can be operated intermittently or batchwise if so desired.
Batch
Dryers are designed to operate on a definite size batch of wet feed for given time cycles. In batch dryers the conditions of moisture content and temperature continuously change at any point in the dryer.
Continuous
Drying is accomplished by material passing through the dryer continuously and in contact with a hot surface.
Batch
Batch indirect dryers are generally well adapted to operate under vacuum. They may be divided into agitated and non-agitated types.
Direct Continuous Types
1. Continuous Tray Dryers such as continuous metal belts, vibrating trays utilizing hot gases, vertical turbo-dryers.
2. Continuous Sheeting Dryers. A continuous sheet of material passes through the dryer either as festoons or as a taut sheet stretched on a pin frame.
3. Pneumatic Conveying Dryers. In this type drying is often done in conjunction with grinding. Material conveyed in high temperature, high velocity gases to a cyclone collector.
4. Rotary Dryers.* Material is conveyed and showered inside a rotating cylinder through which hot gases flow.
5. Spray Dryers. Dryer feed must be capable of atomization either by a centrifugal disc or a nozzle
6. Through-Circulation Dryers. Material is held on a continuous conveying screen, and hot air is blown through it.
7. Tunnel Dryers. Material on trucks is moved through a tunnel in contact with hot gases.
Direct Batch Types
1. Batch Through-Circulation Dryers. Material held on screen bottom trays through which hot air is blown.
2. Tray and Compartment Dryers. Material supported on trays which may or may not be on removable trucks. Air blown across material on trays.
* Certain rotary dryers may be a combination of indirect and direct types; e.g., hot gases first heat an inner shell and then pass between an inner and outer shell in contact with the wet solid.
1. Cylinder Dryers for continuous sheets such as paper, cellophane, textile piece goods, etc. Cylinders are generally steam heated, and rotate.
2. Drum Dryers. These may be heated by steam or hot water.
3. Screw Conveyor Dryers. Although these dryers are continuous, operation under a vacuum is feasible. Solvent recovery with drying is possible.
4. Steam Tube Rotary Dryers. Steam or hot water can be used. Operation on slight negative pressure is feasible to permit solvent recovery with drying if desired.
5. Vibrating Tray Dryers. Heating accomplished by steam or hot water.
6. Special Types such as a continuous fabric belt moving in close contact with a steam heated platten. Material to be dried lies on the belt and receives heat by contact.
1. Agitated Pan Dryers. These may operate atmospherically or under vacuum, and can handle small production of nearly any form of wet solid; i.e. liquids, slurries, pastes or granular solids.
2. Freeze Dryers. Material is frozen prior to drying. Drying in frozen state is then done under very high vacuum.
3. Vacuum Rotary Dryers. Material is agitated in a horizontal, stationary shell. Vacuum may not always be necessary. Agitator may be steam heated in addition to the shell.
4. Vacuum Tray Dryers. Heating done by contact with steam heated or hot water heated shelves on which the material lies. No agitation involved.

that the material is continuously agitated. Sometimes a better scraper shape might assist in better drying. Exchangeable scrapers for different types of material would also be an advantage.

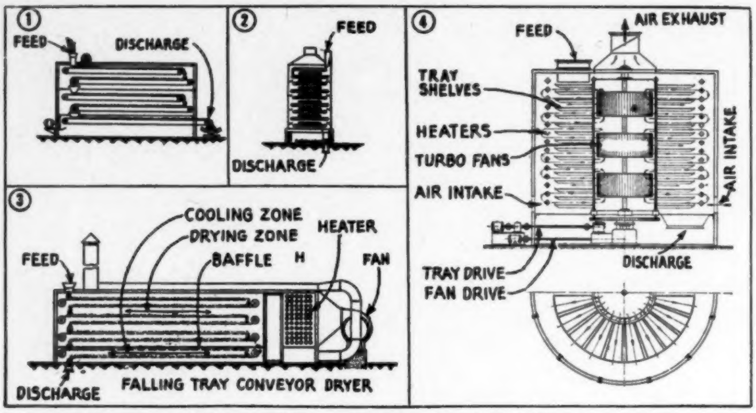
Rotary driers

Direct-fired rotary driers are used where the material can withstand vigorous movement and higher temperatures. Where the hot gases flow on the outside of the shell, increase of flow velocity by baffling can improve heat transfer. Obviously, thermal efficiency of solid-fuel-fired driers depends on the method of firing, on the choice of the correct type of fuel and on the composition of flue gases.

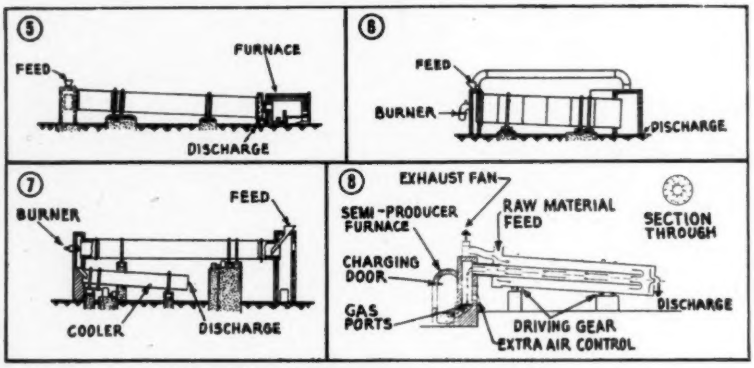
Instrumentation is often incomplete, and better combustion control for firing appliances such as automatic stokers, or gas- or oil-fired furnaces with automatic burner control is highly advisable, but naturally costly. Fig. 5 illustrates a coal- or coke-fired countercurrent type, and Fig. 6 a parallel-flow type with gas or oil burner, used as a calciner. A combined calciner with cooler is shown in Fig. 7, using gas or fuel oil.

It should be noted that in recent years the designs of gas or oil burners have been greatly improved, and replacement of an outdated burner by a modern design gives a good opportunity to increase thermal efficiency. Where producer gas is used, as in Fig. 8, which shows a double-shell type, correct operation of the gas producer is essential. Sometimes the paddles or shelves of a drier have not the right shape, and improvements should be made to speed up or to retard the longitudinal spiral movements, as the case may be. Alteration of the inclination of the axis of the drum also adjusts speed of movement of material. Installation of a dust separator at the air discharge will avoid air entrainment. In those driers where the gases flow along the outer shell, the radiation effect of the hot gases is important. For static-shell types the heat transfer is mainly by conduction. The more intimate the contact is between heating surface and material, the better the drying rate.

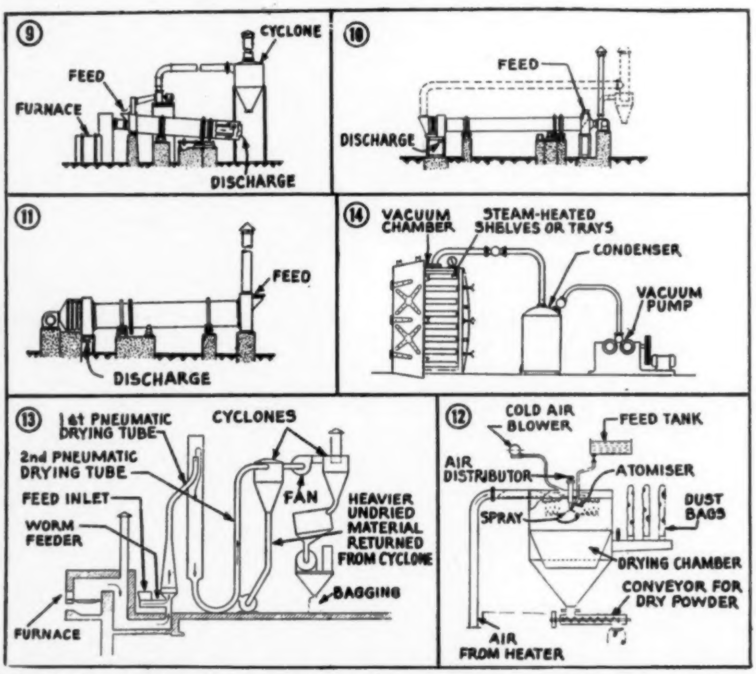
In certain cases recirculation of hot gases for direct-heated rotary driers (Fig. 9) can be added to existing driers during reconstruction. For those materials where direct contact with combustion gases is not permissible, steam heating is applied (Figs. 10 and 11). Countercurrent flow and a suction type with cyclone are employed in Fig. 10, with steam heater battery



Figs. 1 and 2, band driers, and Figs. 3 and 4, falling-tray driers.



Figs. 5-8. Various types of rotary driers.



Figs. 9-14. Further drying methods using rotary, spray, pneumatic or vacuum equipment.

at the discharge end. A pressure type with countercurrent is illustrated in Fig. 11. The simplest type has parallel flow whereby gases and material travel in the same direction. Much depends on correct adjustment of inclination, of speed of rotation, and of efficiency of the heater. Dry steam at constant supply pressure, correct steam trapping and last, but not least, suitable design of the fan and driving motor are factors to be carefully watched. Other indirect heating elements use electricity. It is, of course, possible to use platen- or tube-type heat exchangers between gases of combustion and hot air, which latter is used to come into contact with the material. Wherever heat exchange comes into operation, utmost cleanliness of heat-transfer surfaces has to be maintained. Frequent cleaning of outer and inner surfaces of heater tubes, or of platens, etc., is imperative for drier efficiency. The use of back-pressure or of pass-out steam from steam engines or turbines is, of course, an excellent means for steam economy. High-temperature hot water with pump circulation is another method of generating hot air and heat losses from condensate do not occur here.

Efficiency of spray driers

Modern types of spray driers (Fig. 12) work very efficiently because great progress has been made in design of reliable atomisers. Older types, however, lend themselves to reconstruction of the atomising unit, of filters, and of air heaters. They are also sometimes inadequately instrumented, and modern temperature-humidity and pressure recorders can be used with advantage. The thermal efficiency of spray driers is less important than overall efficiency, but can be more easily assessed. It requires long observation and great experience, together with repeated tests, to obtain optimum output from a spray drier at minimum cost. Sometimes an adjustment of the atomising unit will produce a different size of globules with subsequent improved operation. Provided that the design of the atomising unit is efficient to prevent clogging or uneven atomisation, reliable operation can be expected. Where the high-pressure jet system causes the need for frequent nozzle cleaning with loss of production time, reconstruction and use of a revolving disc unit might improve matters, or the use of a nest of nozzles applying compressed air. The latter must be oil-free, clean from mechanical and other impurities.

Fig. 13 shows the layout of a pneumatic drying plant keeping the particles in suspension during the drying process. What has been said about furnace and combustion efficiency for rotary kilns applies here just the same. Every care has to be taken that the wet material is properly entrained in the hot gas or air stream, and frequent sampling is highly advisable. Measurement of air velocities during the various phases of drying will help considerably to maintain drier performance or to improve it, and easily cleanable pitot tube flow meters can be used to watch the flow volume. In case uneven drying occurs, something is wrong with keeping all globules of wet material in the gas stream, and closer investigations are required, starting from the combustion chamber, and ending at the cyclones and the bagging end. Excessive deposits in the cyclones indicate that the cyclone design is not up to date, or that cyclone surfaces have become rough.

The question of air leakage is most important in pneumatic drying, but occasional tests with the soap solution and air bubble method will soon disclose escaping air. Fan and motor maintenance is another important point to be watched. Sometimes the means for adjusting gas velocity in relation to material characteristics are somehow inadequate when operation should cover different materials. Redesign of dampers, etc., might improve matters, and so does the use of an infinitely variable motor drive gear. Where frequent scorching occurs, the wet particles might vary too much in moisture content, and in shape. The preparation before feeding requires in such instances greater care and attention.

Conclusion

What must be realised by each user of driers is that no universal unit exists which would dry a great diversity of products. Great care has, therefore, to be exercised when using a drying installation for a different material than that for which it has been designed. The writer has repeated experience with driers in operation, which have been bought as second-hand machinery, and have been installed to deal with a completely different material than that for which they have been originally used. It is here that fuel, heat, power and labour can be wasted, and where overall drier efficiency is very low. Replacement of such obsolete driers by modern drying plants, designed for actual working conditions, will be a sound capital investment.

REFERENCES

'A Study of Drying '—papers read at a conference arranged by the Institute of Fuel in London, April 1951.

S. G. Saunders, ' Review of Modern Drying Methods,' series of articles published in the *Ind. Heat. Engr.*, London, 1947.

' The Efficient Use of Fuel,' Ministry of Fuel and Power, London.

W. R. Marshall, Jun., ' Classification Chart Aids Dryer Selection,' *Heat., Piping & Aid Condtng.*, Chicago.

British Standards

Plastics testing (B.S. 2782: 1957, 5s. net, ' Methods of testing plastics, Part 2: Electrical properties '). Part 2 of this standard specifies tests to be applied to moulding and extrusion compounds, synthetic resins and their solutions, and semi-fabricated products such as sheet, thin film, rod and tube. The tests relate to the following properties: electric strength; volume resistivity; surface resistivity; insulation resistance; power factor and permittivity at 50 c/s.; power factor and permittivity at 800 to 1,600 c/s.; and power factor and permittivity at 10 kc/s. to 100 mc/s.

Plastics testing (B.S. 2782: 1957, 7s. 6d., ' Methods of testing plastics, Part 3: Mechanical properties '). The publication provides details of test specimens, apparatus, procedure and calculation of results for the following methods of test: tensile strength and elongation at break, elastic modulus in tension, crushing strength, shear strength, impact strength, indentation and tear strength.

Alumina determination (B.S. 1902: 1957, Addendum No. 1, 3s. 6d. net, ' Methods for the direct determination of alumina '). Part 1 of this addendum specifies a method for the direct determination of alumina in silica rocks, sands and silica refractories containing from 0.1 to 10% alumina; and Part 2 a method for the direct determination of alumina in alumino-silicate refractories and raw materials containing from 10 to 65% alumina.

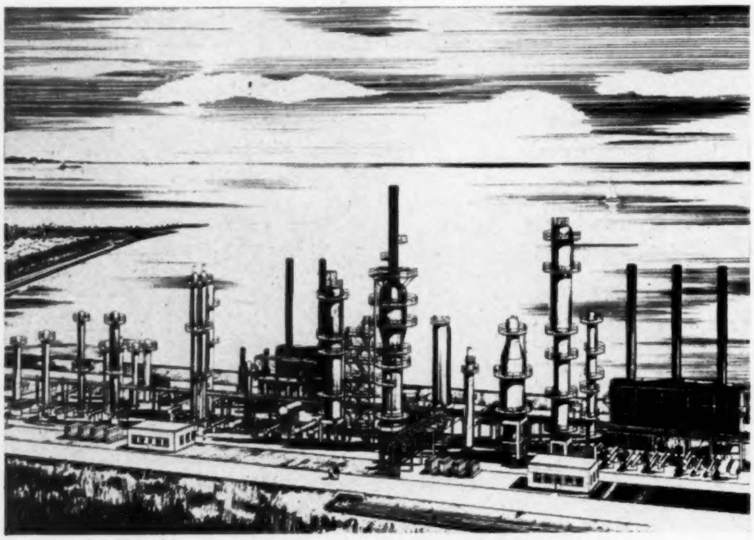
Rubber testing (B.S. 903: 1957, ' Methods of testing vulcanised rubber: Part C: 4 (price 3s.): Determination of electric strength of insulating soft vulcanised rubber and ebonite; Part D.4 (2s. 6d.): Determination of cross-breaking strength of ebonite ').

The AMERICAN Scene

A summary of recent happenings in the United States

The U.S. chemical industry's record capital expenditure of the past two years should be a stimulus to sales and to the development of new markets. While additions to plant capacity do not automatically create sales, there is nothing quite like an idle plant to put a 'forced draught' behind the development of new uses and markets for a chemical, declared Mr. J. O. Logan, vice-president and general manager of the Industrial Chemicals Division of Olin Mathieson Chemical Corporation, at a meeting in New York recently. He predicted a 5% dollar sales rise for 'chemicals and allied products' in 1958. In this category are included not only industrial chemicals but also plastics, synthetic fibres, synthetic rubber, drugs, paints, fertilisers, vegetable and animal oils and a number of smaller miscellaneous groups such as printing inks, toilet preparations and the like.

Expenditures for new plant in 1956 and 1957 will total about $3.3 billion, or 13% of annual sales. The rule of thumb in the chemical industry is that $1 of new plant will generate about $1 of annual sales. On this basis, capacity of the chemical industry will be in excess of estimated sales by about 15% at the end of 1957. By the end of 1958, capacity will have risen to a level about 25% above 1957 sales.



URUGUAYAN OIL REFINERY PROJECT

The capacity of the 'Ancap' La Teja refinery, Uruguay, will be more than doubled and five new units are to be designed and engineered by M. W. Kellogg Co. New York. New facilities planned, illustrated here, include the atmospheric and vacuum unit on the right, 'Orthoflow' fluid cat cracker with stabilisation and reforming units in the centre, gas recovery and treating units on the left. Note that the plot is laid out in a typical in-line arrangement, minimising maintenance problems and pipe-runs and simplifying operation.

Among other factors supporting an upward trend in chemicals, according to Mr. Logan, is the possibility that certain chemical-consuming industries which have been undergoing recession will show some recovery in 1958. These include the textile, pulp-and-paper and automobile industries.

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A significant extension of ion-exchange principles that makes use of a new type of ion-exchange resin has been developed by Dow Chemical Co. for separating water-soluble materials. The new resin has the unusual characteristic that both anionic and cationic exchange sites are located in the same bead, so that the resin sites will adsorb both anions and cations from feed solutions. However, according to information issued by the Armour Research Foundation of the Illinois Institute of Technology, these resin sites are so closely associated that they partially neutralise each other's electrical charges. Thus adsorbed ions are held weakly and may be displaced from resin by use of water as a regenerant.

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A new desulphurisation catalyst is now being produced at American Cyanamid's new plant at Fort Worth, Texas. An extruded cobalt-molybdena catalyst, it reduces the sulphur content of petroleum fractions by conversion to hydrogen sulphide. The new catalyst is claimed to exhibit high sulphur and nitrogen removal efficiency, while high-active metals content, superior porosity and low bulk density are stated to be further features.

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U.S. mining concerns, as well as Canadian, are among those interested in the 340-mile-long, 3,000-ft.-deep

potash deposits under the Saskatchewan prairies, which are probably second to none in size on the North American continent. They are currently being studied by upwards of a score of companies, many of whom are making active preparations for potash mining. The deposits have hitherto lain dormant because the mining of them has been considered uneconomic in view both of mining costs and the limited markets available.

Because the potash content of the prairie soil is usually satisfactory, the local market is comparatively small and, indeed, the total Canadian consumption does not exceed about 40,000 tons p.a. Expanding markets, both in other parts of Canada (chiefly in eastern Canada) and in certain of the American states, together with easier access to the central states of America, are giving the fillip to the development of the prairie deposits.

One of the first companies in the field was the Potash Co. of America, who began operations about two years ago and who have already sunk their shaft to a considerable depth and have begun the construction of a $15 million to $20 million concentrator, which is expected to be placed in production in 1959.

More recently, the International Minerals & Chemical Corporation have announced plans for an immediate start to be made in sinking a shaft on their 450,000-acre site near Esterhazy, 150 miles east of Regina, at the eastern extremity of the potash belt. The contract for the sinking of the shaft and construction of the plant has been placed in the hands of Utah Construction Co., of San Francisco.

Having been engaged in potash mining at the Carlsbad deposits in New Mexico for some years, the International Minerals & Chemical Corporation are currently supplying about one-fifth of the 2 million tons of potash used in the United States. The prairie potash is said to be of a higher grade than that produced at Carlsbad. Since the seams, like those at Carlsbad, lie almost horizontally, similar mining methods will be adopted, though the company's production in Saskatchewan is expected to be at double the rate of production in New Mexico.

Because many of the major North American potash mining firms are expected to be operating simultaneously in New Mexico and Saskatchewan, the U.S. markets supplied by the respective fields will probably be governed by questions of transport, especially freight costs.

RECENT PUBLICATIONS

Pumps. A leaflet concerning developments in both hand-operated and motor-driven diaphragm pumps has been published by Wilkinson Rubber Linatex Ltd., Camberley, Surrey. The new design of the *Linatex* motor-driven diaphragm pump uses a vertically mounted motor making it possible to fit a variety of types, including standard squirrel cage or flameproof, without difficulty.

Dynamite water resistance. Technical information on dynamite water resistance testing is available in the form of a paper which describes refinements that have been made in the current method of measuring this resistance. Copies in either English or French may be obtained by writing to Research Division, American Cyanamid Co., 30 Rockefeller Plaza, New York 20, N.Y.

Valves. A new series of four leaflets describing the construction materials of their valves has just been published by Langley Alloys Ltd., Langley, Slough, Bucks. The leaflets contain helpful information on the selection of alloys for various applications and describe briefly the types of valve in which they are available.

Aluminium treadplate. The British Aluminium Co. Ltd. Norfolk House, St. James's Square, London, S.W.1, have recently issued a pamphlet illustrating the advantages of their P-G-P (positive-grip-pattern) aluminium treadplate which is claimed to be non-rusting and is now available in three patterns.

Rust treatment. A revised leaflet describing the use of various *Foscote* solutions on rusty surfaces prior to painting, has been issued by the Walterisation Co. Ltd., Purley Way, Croydon.

"THEY'VE COME IN ANSWER TO OUR ADVERTISEMENT FOR EXPERIENCED WOMEN IN THE MIXING DEPARTMENT"

Plastics. The organisation of British Industrial Plastics Ltd., of 1 Argyll Street, London, W.1, their products, manufacturing services and technical resources are the subject of an illustrated booklet which they have published.

Polythene pipes. The uses and specifications of polythene pipes for water systems are discussed in a pamphlet issued by the Association of British Merchants Ltd., Peters Hill, Upper Thames Street, London, E.C.4. It also mentions the recent attempts to utilise polythene pipes for domestic hot water purposes.

Odour-free gases. A low-temperature oxidation process by which combustible fumes, vapours, gases and odours of an organic nature are converted to odour-free gases is described in brochure No. 70 produced by W. C. Holmes & Co. Ltd., P.O. Box B.7, Turnbridge, Huddersfield.

Melamine resins. British Oxygen Chemicals Ltd. have produced a booklet indicating how melamine may be used in the production of stoving finishes, and enumerating some of the applications and advantages of finishes of this type. It is obtainable from the company at Vigo Lane, Chester-le-Street, Co. Durham.

Valve guide. A 64-page catalogue entitled 'A Guide to Valve Practice' has been published by Sir W. H. Bailey Ltd., Patricroft, Manchester. The index and diagrams enable the reader to specify any valve quickly.

Electrostatic precipitators. Many devices exist which, when applied intelligently, eliminate most of the impurities contained in industrial gases, but the one apparatus with the widest application for the cleaning of gases and air, and the recovery of valuable products, is the electrostatic precipitator. This is claimed by the Sturtevant Engineering Co. Ltd., Southern House, Cannon Street, London, E.C.4, in a 72-page, profusely illustrated booklet which contains valuable information for those interested in this subject.

Molecular sieves. A new booklet (RF-1026), describing molecular sieves for gas drying, is available from the Linde Department, Union Carbide International Co., 30 East 42nd Street, New York 17, N.Y., U.S. The brochure gives complete information on using molecular sieves as a drying agent for gases. Tables and charts are backed by engineering data enabling many preliminary designs to be based upon the brochure's contents.

Company News

A mobile unit from the Egham technical service laboratories of Shell Chemical Co. has been touring the Midlands demonstrating the applications of *Epikote* resins in the engineering industry. The company reports that many firms are using these resins with success for press tools and foundry patterns. *Epikote* resin copy patterns can be prepared from a wooden master quickly and cheaply, while simple casting of short-run press tools and vacuum forming moulds from the resins is also easily accomplished.

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An order for £54,000 worth of plastics machinery and high-pressure fittings has been obtained by the Burtonwood Engineering Co. Ltd., from the Royal Dutch State Mines. The whole of this equipment is for the manufacture of polythene—a new development for the R.D.S.M.

Another recent order obtained by the company, from France, is for £28,000 worth of plastics equipment. These goods are for a new Normandy plant of the Ethylene Plastique organisation.

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A convenient way of exporting chemicals to the Continent by means of rail tankers has been worked out by Armour & Co. Ltd. Instead of repeated handling of drums at stores and ports, the chemical is simply pumped at the factory into the tank car and discharged into the storage tanks of the customer on the Continent. This represents not only a reduction in transport costs, but enables quicker deliveries. Well over a third of Armour chemicals produced in England are being exported.

Cationic fatty acid derivatives are produced under licence exclusively for Armour & Co. Ltd., London, by Hess Products Ltd. at their Littleborough, Lancs., works.

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Progress of their ten-year development scheme has been reported by Birlec Ltd., electric furnace manufacturers. The buildings under construction at Aldridge mark the beginning of the first stage of the development plan including the erection of a large fabricating works, a heat treatment shop, and works offices. Three bays, totalling 126,000 sq. ft., are at present under construction and represent about a quarter of the space available for factory development within the terms of the ten-year plan.

Humphreys & Glasgow Ltd. held an 'open home' for the oil and chemical industries last month, and put on an exhibition showing the company's range of design and construction work. Wall charts and diagrams showed how the various departments were organised to deal with chemical projects, and an ingenious method of anticipating and recording drawing-office loading throughout a project was demonstrated. In an adjoining room, models of a nuclear power station and of the underground gasification scheme recently taken over by the company from the N.C.B. made a contrast with the coal and coke-handling plant which forms another side of this versatile company's activities.

The company has progressively increased its staff with particular emphasis on chemical engineering personnel capable of meeting the needs of the chemical, oil and process industries, in addition to setting up various specialist departments.

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Formation of a new and separate group to direct project work is announced by Dorr-Oliver Inc., U.S. Over 35 years the company has designed and put into operation some 50 phosphoric-acid or granular-fertiliser plants, the largest of these being the two recent 200,000-tons-p.a. triple superphosphate Florida installations of Davison Chemical and American Cyanamid.

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The name of Costain-John Brown Ltd., a wholly-owned subsidiary of John Brown & Co. Ltd., has been changed to Constructors John Brown Ltd.

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The opening of an office and factory in Tewin Road, Welwyn Garden City, was recently announced by Polypenco Ltd., suppliers of plastics in various forms for fabrication purposes. The company is the British subsidiary of the Polymer Corporation, United States.

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An exhibition staged by Isopad Ltd. and entitled 'Electric Surface Heating' opened on November 4 at the Chester Street, Aston, Birmingham, showrooms of the Midland Electricity Board. Open for two weeks, it includes a selection of electric heating mantles, plant heaters and heating tapes.

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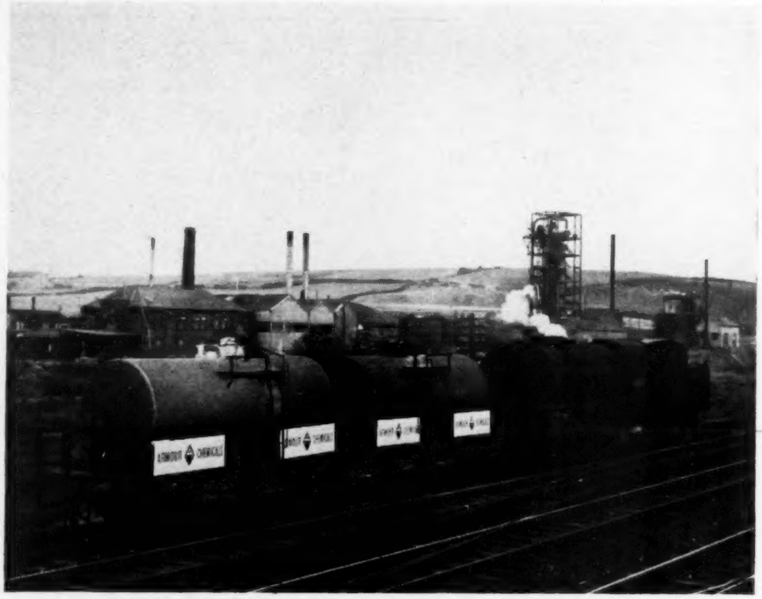
In order to reflect the dual nature—oil and chemical—of operations at Shell's Pernis Refinery, near Rotterdam, two separate operating companies are being formed.

Shell Pernis Raffinaderij N.V. will concern itself with the manufacture of oil products and Shell Pernis Chemische Fabrieken N.V. with petroleum chemicals. The policies and working programmes of the two companies will be closely co-ordinated.



Armour chemicals for export leaving the works at Littleborough.

WHAT'S NEWS about

★**Plant**
★**Equipment**
★**Materials**
★**Processes**

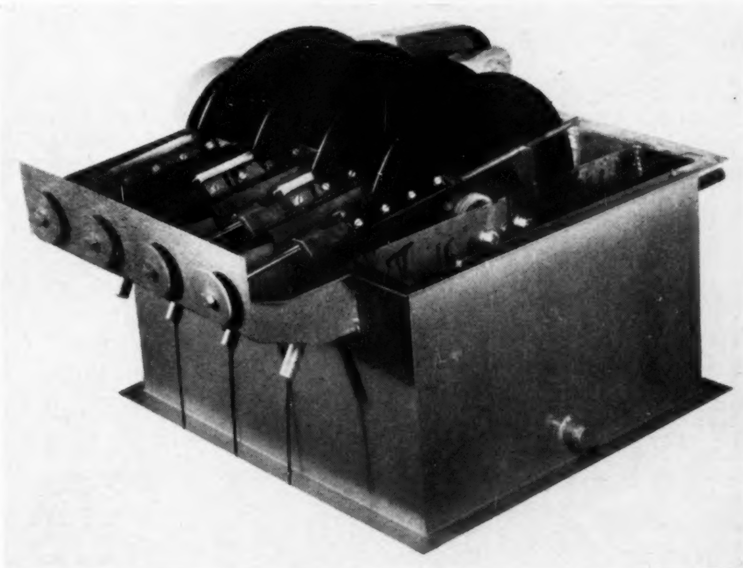
This illustrated report on recent developments is associated with a reader service that is operated free of charge by our Enquiry Bureau. Each item appearing in these pages has a reference number appended to it; to obtain more information, fill in the top postcard attached, giving the appropriate reference number(s), and post the card (no stamp required in the United Kingdom).

Wet reagent feeder

For feeding all types of wet reagent Knapp & Bates Ltd. are producing a disc-type feeder which is claimed to be simple to operate, cheap to install and maintain.

The steel blades gather reagent from the compartments formed and, as they revolve, deliver it to two horizontal steel wipers which are fitted radially to each blade.

The liquid removed by the wipers falls by a trough to a receiving box and is discharged through ½-in.-diam. drain plugs. Complete agitation of the reagent is assured at all times by the rotation of the discs and a constant level is maintained by a ball valve of all-iron construction, although an overflow is provided to guard against spillage. Elimination of cups and tilting bars and the use of stainless-steel discs feeding from a tank and being discharged by wipers gives a clean, simple design, whilst feed can be precisely controlled to an infinite degree between 0.3 and 15 gal./hr./blade. These figures relate to creosote and approximately one-third of this rate is achieved with aqueous solutions. **CPE 746**



Disc-type wet reagent feeder.

Nylon piping

Corrosive liquids can be transported in nylon piping manufactured by Holzverzuckerungs A.G., Switzerland. Called *Grilon*, and claimed to have a broader melting range than many polyamides, namely 215°C., ±5°C., the material is characterised by a shallow viscosity curve between the melting and decomposition temperatures, coupled with a high viscosity at melt. It is therefore particularly suitable for the extrusion process.

A high impact and reversed bend strength is also imparted to the finished pipe, which is furthermore resistant to hot water and subsequent water fractures. Diameters up to 5 in. are available. **CPE 747**

GIANT STEEL PLATES

Greater widths of steel plate to any specification will shortly be made available by the Dohm Group who are at present supplying giant steel plates used in the construction of super tankers, atomic power stations and high-pressure boilers.

The Group has previously dealt with orders for plates up to 12 ft. wide. **CPE 748**

New level indicator

High sensitivity is claimed for a new level controller marketed by Goring Kerr Ltd., comprising an indicator unit and one or two probes (as required) which are inserted in the tank or container.

Any length of cable up to 300 ft. can be supplied for the linking of the probe to the indicator unit, which is useful in cases where top level control in high containers is required, and enables the indicator unit to be placed on a ground-level control panel.

Two types of probe cover most applications. The stick probe is particularly suitable for powders which are adherent to container walls. The flush probe is suitable for most liquids and granular substances. **CPE 749**

Heavy media separation

Made in five basic models, with a capacity range up to 400 tons/hr., *OCC* vessels for all heavy-media separating needs are produced by Pegson Ltd. The vessel is claimed to require a minimum of headroom and floor space. Slow motion and absence of vibration eliminate the necessity for heavy foundations.

Feed material is introduced to the vessel at the surface level of the medium. Float material travels across the vessel and discharges over the float overflow weir. Sink material drops to the bottom of the vessel and is removed by means of an oscillating rake which alternately carries sink to the discharge lips at each end of the vessel. Sink overflows into the launder and thence to the sink discharge chute, which may be designed to discharge at either the front or the rear of the vessel. Float barrier screens in front of each discharge lip effectively prevent the loss of float material with the sink at the instant of discharge to the sink launder. **CPE 750**

Asbestos in plastics

Hayward Tyler glandless pumps, designed primarily for circulating hot water in the heat-exchange systems of steam generators and installed at Calder Hall, use for their water-lubricated bearings a reinforced phenolic resin such as *Ferobestos*. Manufactured by J. W. Roberts Ltd., *Ferobestos* plastics are non-metallic asbestos materials moulded into a hard insoluble and infusible substance by impregnating asbestos cloth with special thermosetting synthetic resins. **CPE 751**

Gas generator

Made in two sizes, to produce 500 and 1,500 cu.ft./hr. of gas, a new *Nitroneal* generator has a built-in vaporiser and is fed with liquid ammonia direct from the cylinders. This is a new and improved model of an apparatus produced by the Baker Platinum Division of Engelhard Industries Ltd. which produces furnace and blanketing atmospheres, consisting of nitrogen with a controllable hydrogen content, using ammonia as fuel.

The gas is produced by cracking the ammonia over a precious metal catalyst into its constituents, nitrogen and hydrogen, and the same catalyst is used to burn the bulk of the hydrogen with atmospheric oxygen to produce a gas containing from 0.5 to 25% hydrogen. The principle advantages obtained by using the special Baker catalyst in this way are that the reaction is exothermic and no external heat source is required and, secondly, that in utilising nitrogen from the atmosphere as well as from the ammonia the gas is produced very economically. **CPE 752**

'Terylene' conveyor belt

A new type of lightweight and non-inflammable belt manufactured by Rubber Improvement Ltd., in conjunction with I.C.I. Ltd., is composed of three plies of *Terylene* reinforced fabric coated with PVC. Half the thickness of a six-ply cotton belt, the new belt is claimed to be lighter and much more flexible, whilst being just as strong and non-inflammable. Troughing is reported to be excellent. **CPE 753**

Bulk transporting vehicle

For use in all industries where granular materials are handled in bulk, the Barfitt bulk transporter has been designed as a low-cost, dual-purpose vehicle capable of handling bulk loads quickly and which can easily be converted to normal load-carrying duties, thus reducing operating costs.

For bulk handling of typical loads, *e.g.* grain or cement, the intake suction system is used for loading, this being carried out at the rate of up to 12 tons/hr.

Off-loading is accomplished by means of the all-aluminium construction and twin-ram tipping gear manufactured by Telehoist Ltd. For rapid loading of sacks another *Telehoist* product, the *Teleloader* automatic hydraulic sack lifter, is fitted. **CPE 754**

Level gauge

For some years it has been recognised that use can be made of the different refractive index between glass and water, and glass and steam or air to provide a positive distinction between the steam and water spaces in water level gauges for high-pressure boilers, and this has usually been done by fixing the two transparent plate glasses at an angle to each other.

In the new RTA gauge, supplied by Richard Klinger Ltd., the two flat plate glasses have parallel surfaces but are off-set, so that the line of sight through the gauge is not perpendicular to them. The line of sight from an observer is, therefore, diverted to a greater extent when passing through the vapour space than when passing through the water and the two emerging angles strike contrasting surfaces in the illuminator fixed at the back of the gauge. These can either be red and green opalescent glass or a white glass screen and darkness.

The gauge is suitable for boiler pressures up to 2,000 p.s.i. **CPE 755**

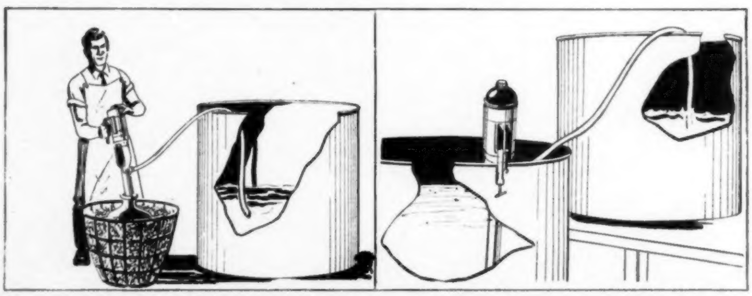
Anti-corrosion enamel

An enamel called *Aktivitt* is claimed to have outstanding adhesion and is impervious to oils, pitch, salt and fresh water, and has been used in the gas industry for coating tar treatment tanks. It is marketed by the Norwegian firm O. Storm Larsen Ltd. **CPE 756**

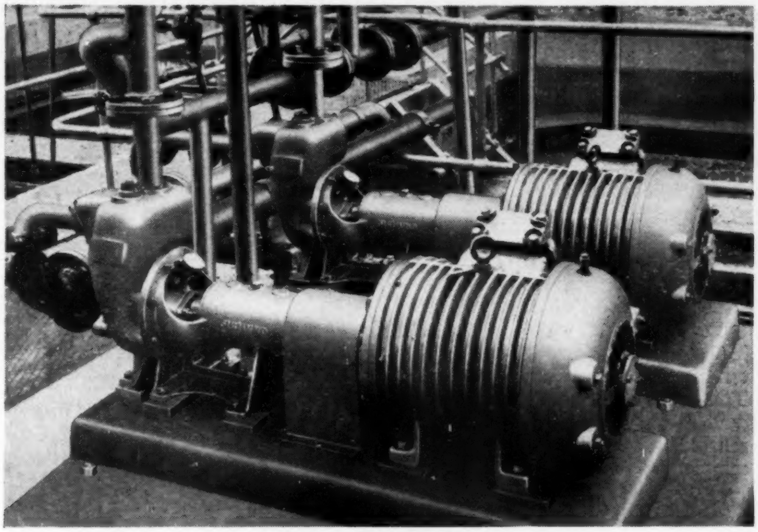
Portable pumps for chemicals

The *Chemix* portable pump unit is primarily designed for the transference of corrosive fluids, from 600 gal./hr. at a 12 ft. head. The immersion depth is 1 ft. 11½ in. and the gland unit is fitted with a special double seal. The pump is constructed in rigid PVC by Plastic Construction Ltd. The motor unit is ⅛ h.p., series wound (complete with switch), suitable for operation on 230/250 a.c. electrical supply. If required the motor can be fitted with a patented variable-speed control which gives a constant torque against load variation.

Special non-corrosive brackets and clamps can be fitted for securing the pump to the side of a vessel when the operator is not in attendance. **CPE 757**



Two versions of the 'Chemix' portable pump: (*left*) the type A being used with a carboy and (*right*) the type B fixed to a vessel.



CHEMICAL PUMPS

These self-priming pumps installed in a chemical works are from a new range of pumps produced by Sigmund Pumps Ltd. with branch sizes from 1½ up to 8 in. and outputs up to 2,500 gal./min. The open-type impeller employed is claimed to make it an ideal unit for handling slurries and similar liquids. **CPE 758**

Floatless liquid level control

Now available for a wide range of industrial applications where it is necessary to control the level of liquid in boilers, tanks or other vessels is a new floatless liquid level control. It has been designed for use in conjunction with electrically driven pumps and incorporates the Teddington patented liquid level switch.

The unit is eminently suitable for steam boiler applications where it can be used for feed water pump control and/or a low water alarm and cut-out. Makers: Meynell & Sons Ltd. **CPE 759**

High-temperature alloys

The name *Nimocast* has been introduced by Henry Wiggin & Co. Ltd. to cover a range of high-temperature nickel-chromium-base alloys for use in the cast form. Six alloys are now available in the series, five of which were developed in the laboratories of the Mond Nickel Co. Ltd.

The *Nimocast* alloys are complementary to the Nimonic series of wrought heat-resisting alloys, some of which were previously included in the Nimonic series, and others were known by laboratory designations. **CPE 761**

Isotope transporting cans

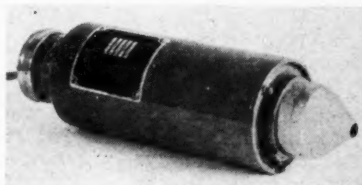
Lead containers specially made to the design and specifications of the U.K.A.E.A. are used to carry isotope cans and other similar vessels in common laboratory use, enabling radioactive and toxic materials to be transported safely outside protected areas. They are manufactured by Savage & Parsons Ltd. **CPE 762**

Re-entrant hot air heater

The *Secomak* re-entrant heater is designed for use where exceptionally high temperatures are required, or where it is desired to reduce the loading of the element to a minimum. The makers claim that temperatures 25% higher than those from standard heaters are now obtainable with a similar loading, or equivalent temperatures with loadings 25 to 30% lower. The maximum nozzle temperature of the re-entrant heater is 900°F.

In this unit, air is preheated by being circulated between concentric tubes before finally passing over the element. An advantage of this is that the outside of the heater runs comparatively cool.

The re-entrant heater may be fitted to the outlet of any *Secomak* blower, or may be used at the end of a pipe or flexible hose. **CPE 763**



Industrial hot air blower.

AIDS TO FILTRATION

Five radically improved grades of calcined German kieselguhr (diatomaceous earth) are now available as filter aids from Charles H. Windschuegl Ltd. The grades, which have been designated 70S New, 80S New, 80SB, 80S Standard and 80 Super, replace former grades. In each case, a regular supply of consistent quality is ensured, bulk volume has been increased by as much as 16%, and the life cycle has been extended. One large brewery reports that in practice yield per dosage has increased to five barrels as against 3½ with the previous grades. **CPE 760**

Versatile infra-red spectrophotometer

The Hilger H800 infra-red spectrophotometer is a recording instrument that can be used either for double-beam or for single-beam working. As a double-beam instrument it passes the blank and sample beams alternately, at a frequency of 12½ c/s., through a monochromator to a fast and sensitive Schwarz thermopile. If the two beams are unequal owing to selective absorption in the sample, the thermopile generates an alternating e.m.f. which, after amplification, is used to enlarge or reduce a two-jaw aperture in the blank beam until the equality of the two beams is restored. The aperture is coupled mechanically to a precision potentiometer, the movement of which regulates the current flowing to the pen recorder. This current therefore bears a direct relation to the transmission of the sample. The wavelength selected by the monochromator is gradually and progressively changed, and the recorder chart is moved in synchronism; the two-jaw aperture maintains balance and controls the ordinate of the pen recorder. This system disposes of the necessity for linear electronic amplification, since the instrument is working on a null point when recording.

The instrument is converted to a single-beam type in a few moments by turning two knobs. In this form, it retains the advantage of null-point working by replacing the blank beam by a pencil of 'white' light direct from the source to the thermopile, by-passing the monochromator.

The instrument has great sensitivity and stability and an example of its performance is that, when using a sodium chloride prism, the resolution at 10μ is better than $1\frac{1}{2}$ wave-number, and the instrument easily resolves the 948.8 cm.$^{-1}$ and 952 cm.$^{-1}$ bands of ammonia when scanning as fast as 1μ a minute. At the same time, the accuracy of measuring transmission is better than $\frac{1}{2}$% of the full-scale deflection, and the reproducibility is of about the same order.

Some advantages of the instrument are:

(1) Prisms are available in rocksalt, potassium bromide, calcium fluoride, lithium fluoride and caesium bromide. Between them, these cover a wavelength range up to about 40μ.

(2) The prism can be replaced by one of a number of gratings used with F-centre filters to eliminate spectra of unwanted orders. The gratings give greater dispersion than a rocksalt prism and are much cheaper than, say, a lithium fluoride prism.

(3) A specially printed recorder chart is available for recording percentage absorbance against wave-number. This is especially useful for compiling card indices of spectra.

(4) A double-beam micro-illuminator allows spectrophotometry of very small samples, *e.g.* single fibres.

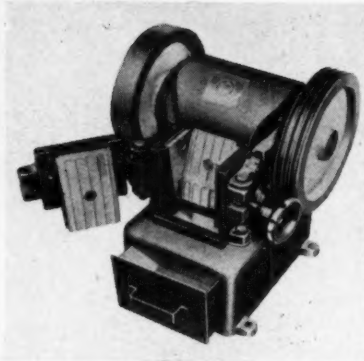
(5) A double-beam reflectance attachment makes it possible to compare the infra-red reflectivities of different substances.

(6) A polariser extends the use of the instrument to the study of crystal structure, supplementing *x*-ray work. It has many other uses.

(7) An integrator measures the area on the chart of an absorption band. This area, being practically independent of slit width, affords the most reliable index to the character of a sample. **CPE 764**

Plastic acid pump

A pump mainly constructed of polythene capable of handling small quantities of corrosive liquids has recently been put on the market by E. M. Francis Ltd. **CPE 771**



LABORATORY JAW CRUSHERS

In the design of their new laboratory jaw crushers, Knapp & Bates Ltd. have paid particular attention to producing maximum strength with the lightest possible construction. To this end, whilst the frame is fabricated from a special aluminium alloy, all crushing, wearing surfaces are of chrome Stellite. The eccentric movement, sited at the top of the moving jaw, is enclosed in a sealed oil bath. This siting allows for a constant discharge opening which ensures a uniform product and eliminates the need for regrinding the crushed product. **CPE 767**

Precious-metal catalytic converters

Following successful test runs with a pilot-scale unit, the Shell Chemical Co. are installing, at their Partington plant, two full-scale catalytic converters for the selective hydrogenation of acetylene in ethylene.

Ethylene of high purity is needed for a number of processes and, in the production of polythene, for example, quite small traces of acetylene are particularly harmful. The removal of acetylene down to very low concentrations can be achieved in a simple manner by selective hydrogenation using supported precious-metal catalysts, a range of which, tailored to suit specific gas streams, has recently been introduced into Britain from America. Developed in the research laboratories of Baker & Co. Inc., of Newark, New Jersey, and proved in U.S. plants, these catalysts are now being manufactured by the Baker Platinum Division of Engelhard Industries Ltd. **CPE 765**

Data logging for process control

Data logging equipment has been designed for continuous scanning of points measuring process variables such as pressure, flow, level and temperature. It presents the information as a printed log sheet or as punched tape suitable for input to a computer. It will also give warning if any point or group of points exceed pre-set limits. (Sunvic Controls Ltd.) **CPE 768**

TITANIUM CASTINGS

Small titanium castings are now being produced for the first time in Britain as a result of a research and development programme initiated by the metals division of Imperial Chemical Industries Ltd.

Saunders valves of the 1-in. type 'A' are now being produced in prototype quantities for plant trials, and other chemical plant components, such as impellers and nozzles, will follow.

In the production of shaped titanium castings, certain problems are encountered not normally experienced in foundry work. Melting and casting must be done in a container large enough to allow all operations to be performed out of contact with air. Secondly, molten titanium reacts rapidly with all conventional moulding materials. Further, the gating and feeding arrangements for casting titanium differ from standard methods, as the time available for the molten metal to fill the mould before solidification is extremely short. In the technique developed, the operation takes less than 10 sec. and results in sound contamination-free castings. **CPE 766**

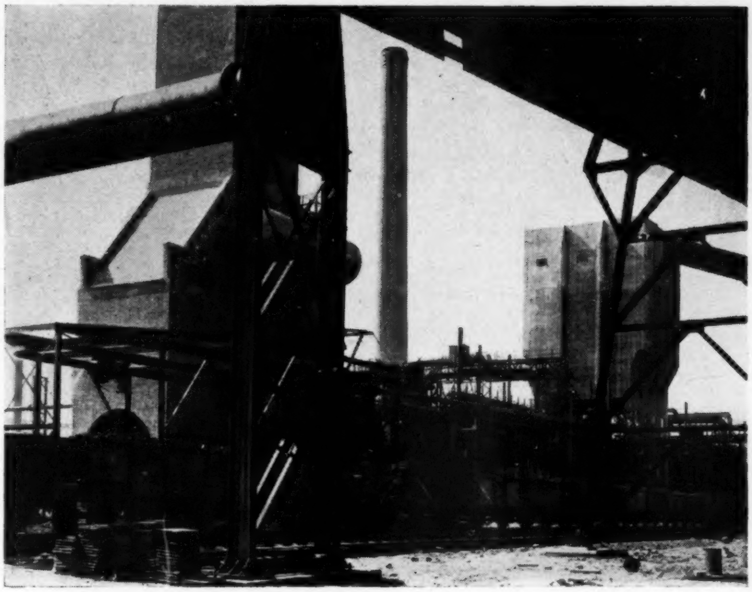
Ion exchange resins for chromatography

To produce ion-exchange resins for chromatographic separation and analytical purposes on a quantity basis, the Permutit Co. Ltd. have set up a new production unit. The resins in the present new range are based on the *Zeo-Karb* 225 and *De-Acidite FF* ion exchange resins. **CPE 769**

Recording load and torque

New load and torque measuring and recording equipment has been designed to give a continuous indication and direct writing pen record of applied load and/or torque in certain plant and machinery utilising rollers, such as rolling mills, in the food and chemical industries and for certain calendering operations in paper-making and in the manufacture of plastics and rubber.

The manufacturers are Savage & Parsons Ltd. **CPE 770**



Coke ovens at Ravenscraig, seen from coke delivery side.

By-products Recovery at Steelworks

A NEW coke-oven, blast-furnace and steelmaking plant has recently been started up at Ravenscraig, in north Lanarkshire, by Colvilles Ltd. with 70 Becker-type combination gas-gun coke ovens designed to carbonise 1,608 tons/day of crushed coal, containing 10% moisture. An interesting feature in the design of the ovens' foundations is the absence of piling and the introduction, instead, of ventilated foundations. The ventilation, which is to prevent drying-out of the clay bed, is effected by providing longitudinal air ducts through the concrete with grids at one end and uptakes at the other. It is expected that the ovens will yield some 620,000 cu.ft./hr. of gas.

The by-products plant is based upon the indirect method of ammonia recovery. A sulphate of ammonia plant has been installed and there is also a benzole plant.

Gas cleaning

The gas-cleaning plant is capable of handling 7½ million cu. ft. of gas at N.T.P. It is anticipated that gas entering with a dust content of 7 grains/cu.ft. will be cleaned so that only 0.005 grains/cu.ft. remain on leaving the precipitators. The gas from the vortex dust-catcher passes first through a packed washer in which it is cooled and partly cleaned. The semi-clean gas is then distributed through the precipitators for final cleaning. The precipitators are of the tubular type, having 260 12-in.-diam. tubes per precipitator. The gas then passes to the consuming points at the power station, hot blast stoves and sinter plant.

The effluent from the washer and precipitators flows in launders to the clariflocculators. From these the underflow passes to the filter plant which produces filter cake for re-use. The overflow water is pumped over a natural draught cooling tower for recirculation in the gas plant. Losses are made up from the blast furnace cooling water return line.

To Authors of Technical Articles and Books

The Editor welcomes practical articles and notes on chemical engineering and related subjects with a view to publication. A preliminary synopsis outlining the subject should be sent to The Editor, CHEMICAL & PROCESS ENGINEERING, Leonard Hill House, Eden Street, London, N.W.1.

In addition, the Publishers and Editors of the Leonard Hill Technical Group are always ready to consider technical and scientific manuscripts with a view to publication. Correspondence should be addressed in the first instance to the Book Production Manager, at the above address.

CPE COST INDICES — LATEST FIGURES

Here are the two latest figures to be added to our cost indices (June 1949 = 100): Chemical Plant Construction Cost Index, August, **173.7;** Equipment Cost Index, August, **164.7.**

MEETINGS

Institution of Chemical Engineers

November 13. 'Fibre Reinforced Plastics in the Chemical Industry,' by F. F. Jaray, 6.30 p.m., Midland Institute, Paradise Street, Birmingham.

November 19. Two papers on pressure vessels by R. W. Lakin and A. N. Other, 7 p.m., Reynolds Hall, College of Science and Technology, Manchester.

November 26. 'Recent Developments in Industrial Low Temperature Gas Separation' (joint symposium with the Low-Temperature Group of the Physical Society), whole day, Royal Institution, 21 Albemarle Street, London, W.1.

December 3. 'Shell Gasification Process and its Application to Industry,' by M. J. Gattiker, 5.30 p.m., Geological Society, Burlington House, London, W.1.

December 3. 'Selection and Operation of Solvent Extraction Equipment,' by J. A. H. Walker, 7 p.m., Birkenhead Technical College, Birkenhead.

Society of Chemical Industry

Road and Building Materials Group

November 21. 'Producer-gas Fired Lime Kilns,' by B. J. Gee, 6 p.m., 14 Belgrave Square, London, S.W.1.

Institute of Fuel

November 21. 'Measurements of Size Droplets from Convergent-divergent Nozzles used in Oil Burners for Steel Furnaces,' by E. J. Burton and J. R. Joyce, and 'Flow and Disintegration of Thin Sheets of Visco-elastic Fuel,' by N. Dombrowski, P. Eisenklam and R. P. Fraser (joint meeting with Institute of Petroleum), 7 p.m., Royal College of Science and Technology, Glasgow.

Institute of Metals

December 5. 'Design and Operation of Waste Heat Boilers in the Chemical Industry,' by W. Gregson (joint meeting with the Chemical Engineering Group of the Society of Chemical Industry), 6.30 p.m., Chemical Department, The University, Woodland Road, Bristol.

Technology Notebook

Houldsworth Society

Sir Harold Smith, chairman of the Gas Council, has been installed as the first hon. president of the newly formed Houldsworth Society at Leeds University. The Society commemorates the late Sir Hubert Houldsworth, chairman of the National Coal Board until his death in February 1956, who was a student and member of the staff of the Coal, Gas and Fuel Department of Leeds University and Pro-Chancellor for six years.

In recent years the department of Coal, Gas and Fuel has expanded and outgrown its title. Two new departments, Chemical Engineering and Metallurgy, have been opened and the parent department renamed the Department of Gas Engineering, General Fuel Science and Ceramics. These three departments now form the Houldsworth School of Applied Science whose 200 students will move into their new £610,000 building in May next year.

Non-destructive testing

The British National Committee for Non-destructive Testing sent a delegation of three members to the Second International Conference on Non-destructive Testing held in Chicago from November 3 to 8. The delegation was led by Dr. L. Mullins, who represented the Society of Non-destructive Examination and is manager of the technical advisory department of Kodak Ltd.

The other members of the delegation were Mr. C. C. Bates, who represented the Institution of Production Engineers and is technical director of Welding Supervision Ltd., and Dr. J. Thewlis, assistant head of the Metallurgy Division of the Atomic Energy Research Establishment at Harwell.

Metal physics symposium

A symposium on 'Vacancies and Other Point Defects in Metals and Alloys' is being arranged by the Metal Physics Committee of the Institute of Metals to be held at Harwell on December 9 and 10.

Practical experience

The opportunity to undertake practical work at the B.P. refineries is given each summer to selected students. About 100 took part in the vacation training scheme this year—first-year students are normally employed on work of a routine nature, while second- and third-year men undertake project work under the guidance of university tutors and company staff.

B.S.I. progress

The annual report of the British Standards Institute shows that the number of current standards totals over 3,000, whilst the number of subscribing members supporting the Institution, over 9,000, is the highest yet reached.

Personal Paragraphs

★ **Mr. G. F. Flatow** has been appointed to the board of Amber Oils Ltd. He was previously technical director. Mr. Flatow came to England in 1939, when he joined Amber Oils Ltd. on the company's specialised oils side. He had previously been with Robart-Bosch and A.E.G. in Germany, with General Motors in the United States and with Junkers and the German Shell Co.

★ Both joint managing directors, **Mr. G. Helps** and **Mr. G. G. Farthing,** were among 36 members of the staff of Humphreys & Glasgow Ltd. to receive gold watches to mark 25 years', or longer, service.

★ Dewrance & Co. Ltd. announce that the board of directors have reluctantly accepted the resignation of their fellow director, **Mr. F. F. H. Halestrap,** who has been with the company for over 59 years. **Mr. J. W. Plowman** and **Mr. D. Handley** have been appointed directors. Mr. Plowman is also chief executive assistant to **Mr. J. M. Storey,** managing director, and Mr. Handley, manager of the company's Dumbarton works.

★ **Mr. E. W. Jones** has been appointed sales manager of Isotope Developments Ltd., Aldermaston. Since joining the company upon its formation in 1950, he has been intimately associated (as head of the applications section) with advances made in the application of nucleonic techniques to industrial measurement and control.

★ The managing director of the Royal Dutch-Shell laboratory of Amsterdam, **Mr. H. W. Slotboom,** has been appointed research co-ordinator of the Bataafsche Petroleum N.V., the operating company of the Royal Dutch. His place as manager of the laboratory will be taken by **Dr. H. Van Driel.**

★ After 29 years' service with Imperial Chemical Industries, **Mr. H. Moss** has retired. For the last seven years he had been officer-in-charge of factory visits and had shown many thousands of visitors over the Billingham works.

★ **Cmdr. M. B. St. John** has been appointed managing director of Liquid Systems Ltd., Croydon, who, with Rubery Owen & Co. Ltd., contract to manufacture the Bowser range of industrial equipment in Britain.

★ **Prof. Preckshot** of the Chemical Engineering Department of the University of Minnesota is spending a year in the Department of Chemical Technology (Edinburgh University—Heriot-Watt College) on a Guggenheim Fellowship. **Mr. A. P. Shahbenderian,** of Fraser's Ltd., has recently been appointed to an assistantship in the same department.

★ Chemical Construction (Great Britain) Ltd. announces that **Mr. J. Curtis,** formerly executive vice-president of the Lummus Co., has become president of its affiliated company in New York, the Chemical Construction Corporation. Mr. Curtis is a graduate chemical engineer from the University of Michigan.

★ The British Aluminium Co. Ltd. announces that the company's expanding interests, particularly overseas, have made it essential to appoint additional executive directors, and to facilitate this **Mr. W. H. Harrison** and **Mr. E. Holland-Martin** have relinquished their directorships. The vacancies thus created, together with one already existing, have been filled by the appointment as directors of **Mr. G. A. Anderson** (to be director and general sales manager), **Mr. W. B. C. Perrycoste** (to be director and general production manager), and **Mr. J. Salter** (to be director and general production manager). **Mr. G. W. Lacey,** at present director in charge of sales, assumes the title of commercial director.

World News

JAPAN

Investment in petrochemical industry

The Japanese Government has approved a project of the Mitsubishi Petrochemical Co. involving the investment of £1,312,500 by the Shell Petroleum Co. of Britain. The capital will be used for the construction of a plant capable of producing 10,000 tons of polythene and 18,000 tons of styrene monomer annually. A Mitsubishi spokesman said his company would give shares worth 90 million yen to Shell for technical aid in the production of a styrene monomer.

Synthetic rubber project delayed

Production of synthetic rubber in Japan is likely to start in 1960 instead of 1959 as previously planned. A spokesman for a Japanese synthetic rubber manufacturing company said the delay was due to financial and technical reasons.

Rubber manufacturers and consumer industries are finding it difficult under the present tight money conditions to raise their contributions to the capital of the semi-official company to be established under legislation passed by the National Diet.

PAKISTAN

Fertilisers

It was announced recently that the I.C.A. has agreed to extend to Pakistan $10 million towards the foreign exchange costs of one or more fertiliser plants to utilise natural gas and each to have an annual capacity of some 117,000 tons of urea or its equivalent. Two possibilities which were also being considered by the Government of Pakistan are the establishment of two fertiliser factories financed by private American and Pakistan capital, and the supply on long-term credit by 'an American party' of machinery for a fertiliser factory.

NETHERLANDS

Sulphuric acid project

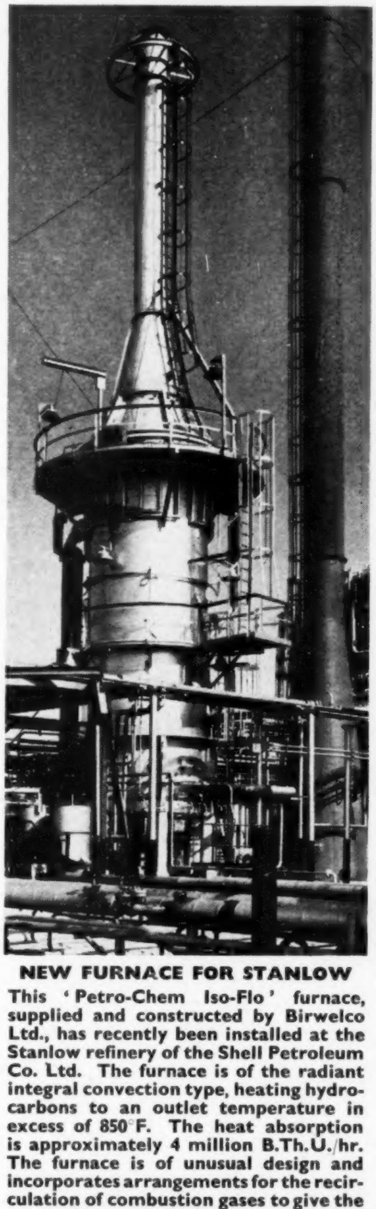
A new factory for producing sulphuric acid on a natural sulphur basis is to be built by N.V. Nieuwe Nederlandsche Maatschappij voor de Vervaardiging van Speigelglas, Glazen Vorrwerpen en Chemische Producten Sas van Gent.

This factory will replace the existing lead-chamber plant and sulphuric acid factory, using pyrites as base material. The company, which was established in 1904 and now has 480 employees, is closely allied to the French glass and chemical concern Saint Gobain.

AUSTRIA

Chemical industry

The value of Austria's production of chemical goods this year is expected to reach 7,500 million Austrian schillings. Basing its estimates on current trends the industry's trade association says this would be about 10% above the sum earned last year. Almost all sections of the industry recorded sizeable production increases during the first half of 1957.



NEW FURNACE FOR STANLOW

This 'Petro-Chem Iso-Flo' furnace, supplied and constructed by Birwelco Ltd., has recently been installed at the Stanlow refinery of the Shell Petroleum Co. Ltd. The furnace is of the radiant integral convection type, heating hydrocarbons to an outlet temperature in excess of 850°F. The heat absorption is approximately 4 million B.Th.U./hr. The furnace is of unusual design and incorporates arrangements for the recirculation of combustion gases to give the unusual heat distribution over the tube coil required by the nature of the process.

GREAT BRITAIN

Uranium from overseas for U.K.A.E.A.

The United Kingdom Atomic Energy Authority are ready to buy annually from existing or future mines in Kenya, Uganda, Tanganyika, Swaziland and British Guiana chemical concentrates containing up to 500 short tons of uranium oxide (U_3O_8). Contracts would cover a ten-year period from the coming into production of a mine, providing that the end date of the period does not extend beyond 1972. The Authority will offer prices which are reasonable in the light of world conditions at the time, having regard to the principles on which prices for uranium have been negotiated elsewhere.

I.C.I. in Argentine plastics project

It is announced in London that a large new factory to manufacture PVC will shortly be built by Electroclor S.A.I.C. at Capitan Bermudez, near Rosario, Argentina. The plant has been designed by Imperial Chemical Industries Ltd. who will also train technical staff for its operation.

JORDAN

Phosphate factory

Jordan Phosphate Co. have decided to set up a large-scale phosphate factory with an annual output of 15,000 tons. The cost of carrying out this scheme, which requires approval of the Ministry of Economy, is about 1 million dinars.

A recent report by the International Bank Mission on the economic development of Jordan stated that the phosphate deposits of the country are of a very good quality and on a par with Moroccan phosphate.

SWITZERLAND

Agency offer

Mineral A.G., Ibach-Schwyz, Brunnen, have informed the British Consulate-General at Zurich that they would like to represent United Kingdom firms who are interested in exporting minerals, ores, crystals, raw materials for ceramics and industrial chemicals.

MANILA

Philippine sulphate fertiliser plant

The National Power Corporation has received bids for a complete

50,000-ton ammonium sulphate fertiliser plant. German firms were reported to have been predominant among the 25 foreign firms which submitted bids. The projected plant is expected to double the country's present fertiliser production. One plant now in operation in Iligan City, on Mindanao Island, has an annual capacity of 50,000 metric tons.

KOREA

Sulphuric acid plant negotiations

The Korean Ministry of Commerce and Industry recently disclosed a plan for the addition of a sulphuric acid plant to the Chung-hang smelter in Chungchong-namdo province. The plant will take twelve months to construct and will have a monthly capacity of 1,800 tons of sulphuric acid of 60°. Raw material from the nearby gold, silver, copper and lead ore smelter would be used.

TURKEY

Caustic soda factory

An agreement has been signed by which the Russians will build a window-glass and bottle factory in Turkey, to be paid for over five years. Building of a caustic soda factory was also agreed in principle. It was emphasised by the head of the Is Bank delegation which visited Moscow that these agreements were signed between the Is Bank, a private concern, and the Soviet authorities.

SOUTH AFRICA

Chemicals and pharmaceuticals

Internatio-Rotterdam (South Africa) (Pty.) Ltd., P.O. Box 3980, Johannesburg, have informed the U.K. Trade Commissioner at Johannesburg that they are interested in obtaining U.K. agencies for various fine chemicals and pharmaceuticals. They are only interested in purchasing in bulk, the particular items in which they are interested being potash, chloroform, mercury, quinine, theophoylline, INH, PAS sodium, PAS acid and nicotinamide.

New coal preparation plant

About three years ago the South African colliery companies and the Iscor steelworks set up a fund that enabled the Fuel Research Institute to erect a coal preparation plant which the South African Minister of Mines has said must be regarded as unique in the world. 'It is unique,' he said, 'not only in embodying no fewer than five different coal cleaning processes, but also because of its flexibility, which allows the widest possible combination of processes.'

A.B.C.M. COUNCIL

The annual general meeting of the Association of British Chemical Manufacturers was held on October 10, and on another page mention is made of the subjects dealt with in the annual report and in the chairman's speech. The Council for 1957-58 will include, as *president*, Mr. W. J. Worboys (Imperial Chemical Industries Ltd.); *vice-presidents*—Dr. F. H. Carr, C.B.E., Sir Roger Duncalfe, Dr. E. V. Evans, O.B.E., Sir Graham Hayman (Distillers Co. Ltd.), Sir Harry Jephcott (Glaxo Laboratories Ltd.), Mr. C. F. Merriam, M.C., Mr. L. P. O'Brien (Laporte Chemicals Ltd.), Mr. G. F. Williams (British Drug Houses Ltd.); and (elected members) *chairman*—Mr. B. Hickson (Hickson & Welch Ltd.); *vice-chairman*—Dr. W. H. Garrett, M.B.E. (Monsanto Chemicals Ltd.); *hon. treasurer*—Mr. J. L. Harvey, M.B.E. (Fullers' Earth Union Ltd.).

INDUSTRY REPORTS . . .

British chemical glassware in Europe

Q.V.F. Ltd., of Fenton, Stoke-on-Trent, and Quickfit & Quartz Ltd., of Stone, Staffs., the chemical glassware companies of the Triplex group, have already anticipated the advent of the European Free Trade Area and the Common Market. Sir Graham Cunningham, chairman and managing director, points out that in Europe, in particular, the companies have established agents and distributors in a number of countries. Unpacking and plant erection instructions are printed in three languages—French, German and English, while in the catalogues and in the factories within this group the dual system of British and metric measurements has been established.

Rarer metals

The production of molybdenum disulphide, which is finding a growing market amongst producers of lubricants for high-temperature applications, was an interesting though relatively small development mentioned by the chairman of Murex Ltd., Mr. A. J. G. Smout, in his annual report of the company's activities. He also mentioned that plans were in hand for the erection at Rainham of an entirely new plant for the production of pure tantalum and niobium powders. This plant is scheduled to come into production in 1959.

Metallurgical production

In view of the growing importance of the electrostatic separation process for rare minerals such as titanium, a high-voltage separator has been developed, and the company's special range of screens has been extended, it was revealed in the annual address of the chairman of G.E.C., Sir Harry Railing. Another development was that to the production of electrical furnaces the company have added a continuous pusher type for the sintering of powder metallurgy products in a hydrogen atmosphere.

New oil-blending plant

Swift and efficient operation has been the aim of planning for the new lubricating oils blending plant of Fina Petroleum Products Ltd. at Barking, Essex. Manual work will be cut to a minimum by the provision of power-driven conveyors, to move the containers in and out of the plant from the storing dumps.